Fishes

U. S. COMMISSION OF FISH AND FISHERIES.

GEORGE M. BOWERS, Commissioner

PART XXIX.

REPORT

OF

THE COMMISSIONER

FOR

THE YEAR ENDING JUNE 30, 1903.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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REPORT

OF THE

UNITED STATES COMMISSIONER OF FISH AND FISHERIES

FOR THE

FISCAL YEAR ENDED JUNE 30, 1903.

The operations of the Commission of Fish and Fisheries for the fiscal year 1903 are outlined in this report, which is respectfully submitted for the information of the President, the Congress, the Executive Departments, and the public at large. The report embodies a résumé of the work of the Commission, detailed records of the waters stocked with food fishes, and a statement of the appropriations under which the work was conducted, together with an account of the general condition of the fisheries of the country, a historical outline of the Commission's operations from 1871 to 1903, and special reports of the assistants in charge of the different divisions of the Commission.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

GENERAL RESULTS.

The work of propagating food fishes and stocking public waters therewith during the fiscal year 1903 was probably more successful than in any previous year in the history of the Commission. More hatcheries were operated than heretofore, all old lines of work were actively pushed, and important new features were taken up. The number of fish distributed was somewhat less than in the previous year, the decrease deing due to seasonal conditions which could not be foreseen or obviated; but various valuable fishes, whose cultivation has not recently or has never before been undertaken, received attention, and plans were made for a greatly increased output hereafter.

The necessity for maintaining the fish supply in public and private waters is becoming more urgent each year, and the applications for all kinds of fish now greatly exceed those of a few years ago, taxing to the utmost the resources of the various hatcheries. In order to keep pace with the increased catch by commercial fishermen and anglers, the establishment of additional hatcheries from time to time is demanded, and larger appropriations are required to operate existing hatcheries to their full capacity.

The practical value of the Commission's work of artificial propagation has long since been removed from the realm of doubt, and is appreciated and conceded by all persons qualified to express an intelligent opinion thereon. This is true of the cultivation of marine species no less than of the river, lake, and pond species. Instances of direct economic returns from the operations of the Commission have been noted from time to time in the official reports, and such instances are continually coming to light. In the present report attention is drawn again to certain noteworthy results of fish culture which have already been discussed, and some new cases of successful stocking of waters are mentioned.

STATIONS OPERATED.

The number of stations and substations in operation in 1903 was 46. Substations are those having no permanent personnel, and, in most instances, are without the complete equipment of the major stations; in other respects, however, they are regular hatcheries, and in some cases their work is more extensive than that of the stations to which, for administrative purposes, they are attached. The location of the hatcheries, by states and regions, is shown in the following table:

Sections and States.	Number.	Sections and States.	Number.
New England:		Great Lakes—Continued.	
Maine	3	Michigan	5
New Hampshire	1	Minnesota	1
Massachusetts	2	North Central:	
Vermont	2	Iowa	2
Middle Atlantic:		Illinois	1
New Jersey	1	Missouri	1
Maryland	2	South Dakota	1
District of Columbia	2	South Central:	
Virginia	1	Tennessee	1
West Virginia	1	Rocky Mountain:	
South Atlantic:		Montana	1
North Carolina	2	Colorado	1
Georgia	1	Pacific:	
Gulf:		California	3
Texas	1	Oregon	2
Great Lakes:		Washington	6
New York	1		
Ohio	1	Total	46

The number of stations at which each of the great commercial species distributed by the Commission was cultivated on a large scale in 1903 is shown in the following tabulation:

Species.	Number of stations.
Lobster	2
Cod	2
Flat-fish	2
Shad	4
Pike perch	2
Yellow perch	2
White-fish	7
Lake trout	5
Salmon	11

FISHES CULTIVATED.

The species of fishes cultivated and distributed in 1903 numbered about 50, and included the leading food-fishes of the rivers, lakes, interior waters, and Atlantic coast. The species whose cultivation had not recently been carried on or had not previously been conducted on a large scale are the mackerel, the sea bass, the scup, and the tautog on the Massachusetts coast, the yellow perch on Potomac River and Lake Champlain, the white perch on Susquehanna River, and the striped bass on Roanoke River. Following is a list in systematic order of the fishes handled, a few minor species incidentally distributed from interior stations being omitted.[a]

List of fishes propagated and distributed by the Fish Commission in 1903.

Siluridæ, THE CAT-FISHES.
- * § *Ictalurus punctatus* (Rafinesque). Spotted Cat; Blue Cat; Channel Cat.
- * § *Ameiurus nebulosus* (Le Sueur). Horned Pout; Bullhead; Yellow Cat.

Catostomidæ, THE SUCKERS AND BUFFALO-FISHES.
- § *Ictiobus bubalus* (Rafinesque). Small-mouthed Buffalo-fish.

Cyprinidæ, THE MINNOWS AND CARPS.
- † ‡ *Cyprinus carpio* Linnæus. Carp. (Cultivated varieties, German Carp, Leather Carp, Mirror Carp, etc.)
- ‖ ‡ *Carassius auratus* (Linnæus). Gold-fish.
- ‖ ‡ *Tinca tinca* (Linnæus). Tench. (Cultivated variety, Golden Tench.)
- ‖ ‡ *Leuciscus idus* (Linnæus). Ide. (Cultivated variety, Golden Ide.)

Clupeidæ, THE SHADS AND HERRINGS.
- * *Alosa sapidissima* (Wilson). Shad.

Salmonidæ, THE SALMONS, TROUTS, WHITE-FISHES, ETC.
- * *Coregonus clupeiformis* (Mitchill). White-fish.
- * *Argyrosomus artedi* (Le Sueur). Lake Herring; Cisco.
- * *Oncorhynchus tschawytscha* (Walbaum). Quinnat Salmon; Chinook Salmon; Tyee Salmon; King Salmon.
- * *Oncorhynchus kisutch* (Walbaum). Silver Salmon; Coho.
- * *Oncorhynchus nerka* (Walbaum). Blueback Salmon; Red-fish; Sockeye.
- * *Oncorhynchus gorbuscha* (Walbaum). Hump-back Salmon.
- * *Salmo gairdneri* Richardson. Steelhead; Hardhead; Salmon Trout.
- * *Salmo irideus* Gibbons. Rainbow Trout.
- * *Salmo salar* Linnæus. Atlantic Salmon.
- * *Salmo sebago* Girard. Landlocked Salmon.
- * *Salmo lewisi* Girard. Yellowstone Lake Trout; Cut-throat Trout; Black-spotted Trout.
- * *Salmo pleuriticus* Cope. Colorado River Trout; Black-spotted Trout.
- * *Salmo stomias* Cope. Arkansas River Trout; Green-backed Trout.
- * *Salmo macdonaldi* Jordan & Evermann. Yellow-finned Trout.
- ‡ * *Salmo trutta* Linnæus. Sea Trout; Salmon Trout.
- ‡ * *Salmo trutta levenensis* (Walker). Loch Leven Trout.
- * *Cristivomer namaycush* (Walbaum). Lake Trout; Mackinaw Trout; Longe; Togue.
- * *Salvelinus fontinalis* (Mitchill). Brook Trout; Speckled Trout.

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[a] The fishes artificially propagated are designated, thus *; those simply collected and distributed, thus §; those propagated as food for other fishes, thus †; those propagated for ornamental purposes, thus ‖; and introduced species, thus ‡.

Salmonidæ, The Salmons, Trouts, White-fishes, etc.—Continued.

* *Salvelinus aureolus* Bean. Golden Trout; Sunapee Lake Trout.

* *Salvelinus marstoni* Garman. Canadian Red Trout.

* *Salvelinus fontinalis* × *aureolus*. Hybrid Trout.

Thymallidæ, The Graylings.

* *Thymallus montanus* Milner. Montana Grayling.

Esocidæ, The Pikes.

§ *Esox lucius* Linnæus. Common Pike; Pickerel.

§ *Esox vermiculatus* Le Sueur. Little Pickerel; Grass Pike.

Scombridæ, The Mackerels.

* *Scomber scombrus* Linnæus. Common Mackerel.

Centrarchidæ, The Basses, Sun-Fishes, and Crappies.

* § *Pomoxis annularis* Rafinesque. Crappie.

* § *Promoxis sparoides* (Lacepède). Strawberry Bass; Calico Bass.

* § *Ambloplites rupestris* (Rafinesque). Rock Bass; Red-eye; Goggle-eye.

* § *Chaenobryttus gulosus* (Cuvier & Valenciennes). Warmouth; Goggle-eye

§ *Micropterus dolomieu* Lacepède. Small-mouthed Black Bass.

* § *Micropterus salmoides* (Lacepède). Large-mouthed Black Bass.

* § *Lepomis pallidus* (Mitchill). Bluegill; Sun-fish.

Percidæ, The Perches.

* § *Stizostedion vitreum* (Mitchill). Pike Perch; Wall-eyed Pike; Yellow Pike; Blue Pike.

* § *Perca flavescens* (Mitchill). Yellow Perch.

Serranidæ, The Sea Basses.

* *Roccus lineatus* (Bloch). Striped Bass; Rock-fish.

* *Morone americana* (Gmelin). White Perch.

* *Centopristes striatus* (Linnæus). Sea Bass.

Sparidæ, The Porgies.

* *Stenotomus chrysops* (Linnæus). Scup; Porgy; Scuppaug.

Labridæ, The Labrids.

* *Tautoga onitis* (Linnæus). Tautog; Black-fish.

Gadidæ, The Cods.

* *Gadus callarias* Linnæus. Cod.

Pleuronectidæ, The Flounders.

* *Pseudopleuronectes americanus* (Walbaum). Winter Flounder.

Crustaceans.

* *Homarus americanus* Edwards. American Lobster.

SUMMARY OF DISTRIBUTION.

The fish and fertilized ova distributed in 1903 are shown in the appended table. The aggregate output, somewhat more than one and a quarter billions, exceeded that of any previous year except 1902. While the Commission at its various inland stations makes adequate provision for keeping up the supply of fishes that are sought by anglers, it is noteworthy that more than 98 per cent of the fish handled are those which are caught by commercial fishermen and thus enter directly into the food supply of the country.

Summary of distribution.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Shad	2,555,000	117,862,544		120,417,544
Striped bass		3,125,000		3,125,000
Quinnat salmon	15,514,177	23,852,956	5,450	39,372,583
Atlantic salmon		1,582,409	303,614	1,886,023
Landlocked salmon	180,000	203,422	415,321	798,743
Silver salmon	680,800	81,812		762,612
Blueback salmon		3,731,789		3,731,789
Steelhead trout	80,000	800,255	413,041	1,293,296
Loch Leven trout		223,360	1,400	224,760
Rainbow trout	217,000	726,758	476,999	1,420,757
Black-spotted trout	20,000	200,900	2,528,800	2,749,700
Brook trout	986,000	6,306,774	806,211	8,098,985
Lake trout	8,285,896	29,278,082	25,251	37,589,229
Lake herring		1,500,000		1,500,000
Scotch sea trout	2,500		174	2,674
Golden trout		16,825	4,200	21,025
Canadian red trout			535	535
Hybrid trout			1,720	1,720
Grayling	445,000	974,114	368	1,419,482
White-fish	63,327,000	246,956,040		310,283,040
Pike perch	81,500,000	138,439,203	3,915	219,943,118
Cat-fish			200,380	200,380
Yellow perch	8,000,000	21,467,500	30,450	29,497,950
White perch	445,000	30,863,000		31,308,000
Pike			15	15
Buffalo-fish			200,000	200,000
Black bass			528,365	528,365
Crappie			398,511	398,511
Strawberry bass			3,850	3,850
Rock bass			47,844	47,844
Warmouth bass			1,400	1,400
Sun-fish			432,545	432,545
Cod		87,392,000		87,392,000
Flat-fish		245,425,000		245,425,000
Tautog		5,867,000		5,867,000
Scup		280,000		280,000
Mackerel		281,000		281,000
Sea bass		920,000		920,000
Lobster		68,631,000		68,631,000
Total	182,238,373	1,036,988,743	6,830,359	1,226,057,475

The following table shows the extent to which the different states and territories were included in the distribution. The figures include the transfers of fish and eggs to state commissions, as well as those fish planted directly by the Commission in state waters:

Distributions and assignments of fish and eggs in the States and Territories.

State or Territory.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Alabama	Rainbow trout			3,100
	Cat-fish			12,000
	Black bass			33,645
	Crappie			200
	Rock bass			200
	Sun-fish			6,700
Arizona	Rainbow trout			1,200
	Black bass			525
	Crappie			300
	Rock bass			400
Arkansas	Quinnat salmon			100
	Rainbow trout		12,000	7,300
	Black bass			4,850
	Rock bass			400
	Strawberry bass			100
California	Quinnat salmon	11,513,777	1,618,066	
	Brook trout	200,000		

Distributions and assignments of fish and eggs in the States and Territories—Continued.

State or Territory.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado	Landlocked salmon			4,500
	Steelhead trout			29,000
	Rainbow trout		26,000	1,900
	Black-spotted trout			1,651,900
	Brook trout		1,520,200	295,700
	Lake trout		5,000	2,400
	Grayling		40,000	
	Black bass			1,300
	Crappie			225
Connecticut	Shad		2,559,000	
	Landlocked salmon	10,000		
	Rainbow trout	20,000		
	Brook trout			4,300
	Lake trout	250,000		
	Pike perch		495,000	
	Black bass			1,800
	Crappie			500
	Lobster		3,000,000	
Delaware	Shad		8,050,000	
	Rainbow trout			800
	Black bass			400
District of Columbia	Shad		1,506,579	
	Atlantic salmon			100
	Landlocked salmon			100
	Rainbow trout			112
	Brook trout			100
	Scotch sea trout			12
	Grayling			12
	Pike perch		833,330	
	Yellow perch	8,000,000		
Georgia	Shad		1,938,000	
	Rainbow trout			10,700
	Cat-fish			49,425
	Black bass			74,168
	Crappie			1,550
	Strawberry bass			800
	Rock bass			800
	Warmouth bass			1,400
	Sun-fish			11,400
Idaho	Rainbow trout			2,500
	Black-spotted trout		100,000	26,000
	Brook trout			18,000
	Steelhead trout			8,000
Illinois	Rainbow trout			1,500
	Pike perch			100
	Cat-fish			500
	Yellow perch			6,450
	Buffalo-fish			15,000
	Black bass			32,389
	Crappie			39,925
	Rock bass			1,620
	Sun-fish			28,250
Indiana	Loch Leven trout			400
	Pike perch		11,150,000	
	Black bass			18,949
	Crappie			2,485
	Rock bass			1,454
Indian Territory	Rainbow trout			400
	Black bass			2,565
	Crappie			500
	Rock bass			1,450
Iowa	Quinnat salmon		7,000	2,700
	Steelhead trout			42,500
	Loch Leven trout		4,360	
	Rainbow trout		258,850	102,200
	Brook trout		100,000	395
	Lake trout		9,700	
	Pike perch		760,000	3,815
	Cat-fish			81,530
	Yellow perch			19,000
	Buffalo-fish			160,000
	Black bass			8,030
	Crappie			305,910
	Rock bass			1,050
	Sun-fish			353,360
	Pike			15
Kansas	Rainbow trout			1,700
	Black bass			15,075
	Crappie			1,000
	Rock bass			4,550

Distributions and assignments of fish and eggs in the States and Territories—Continued.

State or Territory.	Species.	Eggs.	Fry.	Finger-lings, year-lings, and adults.
Kentucky	Rainbow trout			500
	Pike perch		700,000	
	Black bass			8,505
	Crappie			6,640
	Rock bass			1,400
	Sun-fish			400
Louisiana	Black bass			2,000
	Strawberry bass			2,900
	Rock bass			100
Maine	Atlantic salmon		1,582,409	303,414
	Landlocked salmon	70,000	196,122	370,550
	Steelhead trout		5,582	353
	Brook trout	350,000	860,000	115,137
	Lake trout		40,646	
	Scotch sea trout			162
	Grayling		17,114	
	Lobster		32,700,000	
Maryland	Shad	1,133,000	36,217,965	
	Rainbow trout	57,000		13,800
	Brook trout			2,400
	White perch		30,863,000	
	Black bass			93,646
	Crappie			200
	Rock bass			150
Massachusetts	Shad		1,350,000	
	Landlocked salmon	25,000		1,400
	Rainbow trout			2,600
	Brook trout	75,000	24,975	3,024
	Lake trout			100
	Scotch sea trout	2,500		
	Pike perch	10,000,000	997,000	
	Black bass			2,000
	Crappie			500
	Cod		87,392,000	
	Flat-fish		245,425,000	
	Tautog		5,867,000	
	Scup		280,000	
	Mackerel		281,000	
	Sea bass		920,000	
	Lobster		31,431,000	
Michigan	Landlocked salmon	20,000		600
	Steelhead trout		24,800	
	Loch Leven trout		80,000	1,000
	Brook trout		901,000	
	Lake trout	1,000,000	19,425,000	
	Grayling	200,000		
	White-fish		147,650,000	
	Pike perch	30,000,000	17,600,000	
	Black bass			3,155
	Crappie			750
	Rock bass			300
Minnesota	Steelhead trout		23,313	
	Rainbow trout		2,000	
	Brook trout		73,500	1,100
	Lake trout		1,580,000	
	Pike perch		3,300,000	
	Cat-fish			450
	Black bass			2,350
	Crappie			400
Mississippi	Black bass			12,300
	Crappie			2,196
	Rock bass			2,350
Missouri	Quinnat salmon			2,400
	Rainbow trout	10,000	2,425	22,868
	Steelhead trout			2,900
	Brook trout	30,000		
	Lake trout		900	
	Grayling	85,000		
	Pike perch	10,000,000	800,000	
	Cat-fish			50,625
	Black bass			4,003
	Crappie			1,150
	Rock bass			11,550
Montana	Steelhead trout			6,000
	Rainbow trout			23,900
	Black-spotted trout		20,000	246,000
	Brook trout	10,000		68,000
	Grayling		887,000	
	White-fish		600,000	
Nebraska	Rainbow trout	50,000		1,000
	Brook trout	50,000		
	Black bass			2,350
	Crappie			900
	Rock bass			100

Distributions and assignments of fish and eggs in the States and Territories—Continued.

State or Territory.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
New Hampshire	Landlocked salmon	20,000		19,398
	Steelhead trout			5,240
	Rainbow trout			3,634
	Brook trout	60,000	345,590	83,425
	Lake trout	800,000	171,695	8,951
	Golden trout		16,825	4,200
	Hybrid trout			1,720
	Grayling		30,000	
	Pike perch		500,000	
	Black bass			590
	Lobster		1,500,000	
New Jersey	Shad	85,000	7,755,000	
	Rainbow trout			1,200
	Brook trout	20,000		300
	Black bass			1,400
	Rock bass			100
New Mexico	Rainbow trout			5,100
	Cat-fish			200
	Black bass			675
	Rock bass			500
New York	Shad	1,337,000		
	Atlantic salmon			100
	Landlocked salmon	10,000	4,300	600
	Rainbow trout	14,000		970
	Brook trout		207,000	4,000
	Lake trout	2,110,896	6,489,051	
	White-fish	275,000	25,257,000	
	Pike perch	1,500,000	1,600,000	
	White perch	445,000		
	Black bass			1,000
North Carolina	Shad		22,941,000	
	Striped bass		3,125,000	
	Landlocked salmon	5,000		
	Rainbow trout		15,000	22,808
	Brook trout			4,300
	Lake trout	25,000		
	Black bass			4,009
	Crappie			300
	Rock bass			1,100
North Dakota	Steelhead trout		9,000	
	Brook trout			900
	Black bass			900
Ohio	Landlocked salmon		3,000	
	Brook trout		70,000	
	Lake trout		491,600	
	White-fish		71,125,000	
	Pike perch		76,975,000	
	Lake herring		1,500,000	
	Black bass			4,705
	Crappie			1,925
	Rock bass			1,100
Oklahoma	Rainbow trout			1,700
	Black bass			3,825
	Crappie			900
	Rock bass			2,150
Oregon	Quinnat salmon	3,506,400	13,440,700	250
	Silver salmon	680,800		
	Steelhead trout		262,700	37,033
	Black-spotted trout		80,900	
	Brook trout		4,995	
	Lake trout		11,490	
Pennsylvania	Shad		900,000	
	Rainbow trout			23,200
	Brook trout		170,000	32,000
	Lake trout	1,500,000	15,000	
	White-fish	38,052,000		
	Pike perch	30,000,000	3,050,000	
	Black bass			12,130
	Crappie			360
	Rock bass			2,200
Rhode Island	Black bass			1,000
South Carolina	Shad		3,145,000	
	Rainbow trout			1,800
	Black bass			2,615
	Rock bass			2,800
South Dakota	Loch Leven trout		129,500	
	Rainbow trout		36,500	31,500
	Black-spotted trout			534,900
	Brook trout		467,500	42,100
	Black bass			5,500
	Crappie			600
	Rock bass			100

Distributions and assignments of fish and eggs in the States and Territories—Continued.

State or Territory.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Tennessee	Rainbow trout		122,750	51,242
	Brook trout			1,500
	Pike perch		700,000	
	Black bass			6,154
	Crappie			1,250
	Rock bass			1,100
Texas	Shad		2,000,000	
	Rainbow trout			500
	Cat-fish			50
	Black bass			101,175
	Crappie			225
	Strawberry bass			50
	Rock bass			5,450
	Sun-fish			2,435
Utah	Landlocked salmon	10,000		
	Steelhead trout	20,000		
	Rainbow trout	25,000		
	Brook trout	50,000		3,000
	Grayling	100,000		
Vermont	Landlocked salmon			18,173
	Steelhead trout		19,860	30,000
	Rainbow trout			2,557
	Brook trout	1,000	1,025,300	22,611
	Lake trout	300,000	178,000	
	Canadian red			535
	Grayling			356
	White-fish		450,000	
	Pike perch		16,112,203	
	Yellow perch		21,467,500	
	Black bass			1,950
Virginia	Shad		29,000,000	
	Rainbow trout	1,000	171,234	107,708
	Brook trout		72,531	40,615
	Pike perch		1,666,670	
	Black bass			50,557
	Crappie			1,820
	Rock bass			2,720
Washington	Quinnat salmon		8,787,190	
	Silver salmon		81,812	
	Blueback salmon		3,731,789	
	Steelhead trout		440,000	252,015
	Rainbow trout		7,499	1,900
	Black-spotted trout			57,000
	Brook trout		55,483	19,314
	Lake trout			13,800
	White-fish		274,040	
	Black bass			200
West Virginia	Shad		500,000	
	Rainbow trout		65,000	6,500
	Brook trout	25,000	145,000	34,490
	Cat-fish			200
	Black bass			2,800
	Crappie			600
	Rock bass			400
Wisconsin	Steelhead trout	20,000	15,000	
	Rainbow trout			9,800
	Brook trout		159,500	5,000
	Lake trout	2,000,000	560,000	
	White-fish	25,000,000	1,600,000	
	Pike perch		1,200,000	
	Cat-fish			5,000
	Yellow perch			5,000
	Buffalo-fish			25,000
	Black bass			2,550
	Crappie			25,000
	Sun-fish			30,000
Wyoming	Steelhead trout	20,000		
	Loch Leven trout		9,500	
	Rainbow trout	30,000	7,500	6,500
	Black-spotted trout			13,000
	Brook trout	80,000	104,200	4,500
	Lake trout	200,000		
	Grayling	60,000		
	Black bass			700
	Crappie			200
	Rock bass			250

CAR AND MESSENGER SERVICE.

This is an indispensable adjunct of the fish-cultural work, being the medium through which the output of the hatcheries is transferred to the waters to be stocked. The transportation of the immense numbers of fish annually handled by the Commission is made possible only by the use of specially constructed railway cars, of which five were operated in 1903. The work of the cars is supplemented by detached messengers, who accompany consignments of fish in baggage cars. For making small shipments to places off the main lines the detached service is more economical and convenient. In 1903 the transportation cars were hauled 79,378 miles and the detached messengers traveled 260,027 miles. Some of the railroads, appreciating the benefits conferred by the Commission in stocking waters along their routes, haul the cars and carry the messengers free of charge. Following is a statement of the free transportation provided by the railroads in 1903. The thanks of the Commission and of the people along the respective lines are due these companies for the liberal policy pursued in this matter.

Statement of miles of free transportation furnished by certain railroads.

Name of railroad.	Cars.	Messengers.
Atchison, Topeka and Santa Fe	....	370
Baltimore and Ohio	693	....
Bangor and Aroostook	2,298	668
Boston and Maine	185	12,585
Burlington and Missouri River in Nebraska	893	5,270
Burlington, Cedar Rapids and Northern	882	40
Central Vermont	....	14
Chesapeake and Ohio	1,156	270
Chicago and North Western	....	1,130
Chicago, Burlington and Quincy	3,588	1,894
Chicago, Rock Island and Pacific	446	312
Colorado and North Western	....	52
Colorado and Southern	....	3,160
Colorado and Wyoming	....	50
Colorado Midland	....	1,469
Colorado Springs and Cripple Creek District	....	92
Cooperstown and Charlotte Valley	....	64
Crystal River	....	42
Delaware, Lackawanna and Western	....	371
Denver and Rio Grande	....	11,517
Detroit and Mackinac	954	252
El Paso and North Eastern	....	330
Fort Worth and Denver City	....	1,728
Franklin and Megantic	....	62
Grand Rapids and Indiana	609	....
Great Northern	....	565
Gulf, Colorado and Santa Fe	....	6,293
Houston and Texas Central	....	1,127
Illinois Central	....	7
International and Great Northern	386	8,811
Iron Mountain and Greenbrier	....	40
Jacksonville and St. Louis	....	36
Kansas City Southern	....	471
Knoxville and Bristol	....	40
Maine Central	3,803	3,602
Michigan Central	238	....
Missouri, Kansas and Texas	....	421
Missouri Pacific	1,196	582
Mobile and Ohio	2,166	....
Montana	188	376
Montpelier and Wells River	....	193
Norfolk and Western	554	4,752
Oregon Short Line	526	932
Northern Pacific	....	436
Pere Marquette	417	393
Phillips and Rangeley	....	58
Portland and Rumford Falls	188	162
Rio Grande Southern	....	90
Rio Grande, Pagosa and Northern	....	62
Rio Grande Western	....	584
Rutland	....	1,283
St. Johnsbury and Lake Champlain	77	1,939
St. Louis and Northern Arkansas	....	132
St. Louis and San Francisco	2,644	2,629
St. Louis South-western	....	824
San Antonio and Aransas Pass	....	498
Sandy River	....	58
Sebasticook and Moosehead	....	16
Somerset	82	....
Southern	....	85
Southern Pacific	....	996
Spokane Falls and Northern	....	610
Tacoma Eastern	....	48
Tennessee Central	198	....
Terminal Railroad Association of St. Louis	4	....
Texas and Pacific	1,062	2,283
Texas Midland	....	40
Union Pacific	....	328
Vandalia	371	....
Virginia-Carolina	....	32
Wabash	534	1,610
Washington County (Me.)	188	204
Wichita Valley	....	102
Total	26,526	85,492

RELATIONS WITH THE STATE FISH COMMISSIONS.

The Commission aims to aid and cooperate with the fishery authorities of the different states in every possible way, and has continued the long-prevailing practice of supplying to state hatcheries eggs and young of various species which, when hatched or reared, are distributed under the direction of the state fish commissions. The states whose hatcheries which were thus stocked by the government in 1903 numbered 16 and the eggs and fish supplied aggregated 170,227,000, as follows:

States and species.	Number of eggs.	States and species.	Number of eggs.
California:		New Hampshire:	
Brook trout	200,000	Brook trout	50,000
Quinnat salmon	10,135,777	Lake trout	500,000
Connecticut:		Landlocked salmon	10,000
Lake trout	250,000	New York:	
Landlocked salmon	10,000	Lake trout	1,830,896
Rainbow trout	20,000	Oregon:	
Shad	*a* 2,559,000	Quinnat salmon	3,006,400
Maine:		Pennsylvania:	
Brook trout	300,000	Lake trout	1,500,000
Landlocked salmon	30,000	Pike perch	30,000,000
Maryland:		White-fish	38,052,000
Rainbow trout	50,000	Utah:	
Shad	1,028,000	Brook trout	50,000
Massachusetts:		Grayling	100,000
Brook trout	70,000	Landlocked salmon	10,000
Landlocked salmon	20,000	Steelhead trout	20,000
Pike perch	10,000,000	Vermont:	
Shad	*a* 1,350,000	Lake trout	300,000
Michigan:		Wisconsin:	
Grayling	200,000	Lake trout	2,000,000
Lake trout	1,000,000	White-fish	25,000,000
Landlocked salmon	20,000	Wyoming:	
Pike perch	30,000,000	Brook trout	60,000
Missouri:		Grayling	60,000
Brook trout	30,000	Lake trout	200,000
Grayling	85,000		
Pike perch	10,000,000	Total	170,207,073
Nebraska:			
Brook trout	50,000		
Rainbow trout	50,000		

a Fry.

At the request of the Michigan authorities this Commission has operated, as substations of the Northville hatchery, the stations of the Michigan fish commission at Detroit and Sault Ste. Marie for the propagation of white-fish, lake trout, and pike perch.

RELATIONS WITH FOREIGN COUNTRIES.

The Commission has continued its practice of furnishing, on request, fish and ova to foreign governments or to foreigners prominently identified with fish-cultural work, and in 1903 supplied fertilized eggs to the following countries, in addition to planting 300,000 lake trout in the Canadian waters of Lake Superior:

Countries.	Species.	Number of eggs.
Ireland	Brook trout	25,000
Wales	Landlocked salmon	10,000
	Steelhead trout	20,000
	Lake trout	50,000
Germany	Rainbow trout	10,000
	Black-spotted trout	20,000
	Brook trout	10,000
Switzerland	Lake trout	50,000
Tasmania	Quinnat salmon	494,000
	Total	689,000

NOTE.—Four hundred yearling spotted cat-fish were sent to the Belgian minister of agriculture, Brussels.

NEW STATIONS.

Ground was broken July 22, 1902, for the construction of the station near White Sulphur Springs, W. Va. During the year a hatchery has been built, and sufficient progress made with the pond system to permit fish-cultural operations to begin. The hatchery is a frame building on a brick foundation, is 1½ stories high, 74 feet long, and 32 feet wide, with extensions in front and rear; there are a hatching room, an office, and entrance and stair halls on the first floor, and 5 sleeping and 2 storage rooms in the attic. The hatching room is equipped with 44 troughs 11 feet 8 inches long, 12¾ inches wide, and 8 inches deep, arranged in groups of four, the upper pair of each group discharging into the lower, whence the water may be turned into ponds or waste drains as desired. A 6-inch pipe, carried along under the floor at the head of the line of troughs, supplies each pair with water through a standpipe. Water is brought to the hatchery from the spring through an 8-inch Wyckoff wooden pipe line 1,365 feet long. A proper head is maintained at the spring by means of a concrete dam 50 feet long. Below the confluence of the overflow from the spring and several small runs a similar dam 35 feet long has been built, forming a reservoir for the pond supply, from which the water is conducted by means of an open ditch connected with the reservoir by 176 feet of 18-inch terra-cotta pipe. Twelve rearing ponds 50 feet by 8 feet have been completed, besides the greater part of the excavation for one large pond 0.45 acre in extent. A trussed wagon bridge has been built over Wade Creek, and 5 smaller bridges over the open ditch. Several hundred feet of 4, 6, and 8 inch terra-cotta drainpipe have been laid, and suitable roads constructed. The old channel of Wade Creek—a water course flowing through a part of the grounds—has been straightened, and retaining walls, cribwork, and levees have been built along it and for a considerable distance along Spring Branch, the outlet of the spring, to guard against danger from overflows and erosion of the banks.

One portion of the property selected for the lobster hatchery at Boothbay Harbor, Me., containing 7.2 acres, was acquired May 12,

1903, and another portion, containing 1.6 acres, was purchased June 26, 1903. These purchases will permit the beginning of work at an early date. Negotiations for one more small parcel needed are progressing, and all the land requisite will soon be in possession of the government.

The sundry civil bill, approved March 3, 1903, provided for the establishment of a fish-cultural station at or near the town of Mammoth Spring, Ark., and in that month a representative of the Commission visited the locality and made a favorable report on a site near the town. Negotiations for its purchase have begun.

It was found that the cost of maintaining a substation at Charlevoix, Mich., on Lake Michigan, would be less than the expense of making the necessary distribution of eggs and fry in that vicinity, and that if the eggs, after being eyed, were transferred and hatched at Charlevoix, they would produce a larger number of fish for distribution and in better condition than would result from hatching them at Northville and transferring the fry to their destination in the cars. A substation was therefore established at this point, consisting of a frame building, 18 by 36 feet, with 10-foot posts, located on the grounds of the United States Life-Saving Service. It is fully equipped for hatching lake trout and white-fish eggs, and an excellent water supply is furnished free of charge by the village of Charlevoix. The total expense incurred in building and equipping this substation was $1,260.69, and the cost of hatching and distributing the output was $524.22. Another season it is believed that the station can be stocked with 25,000,000 to 30,000,000 white-fish eggs and 5,000,000 lake trout eggs, and that these can be hatched and distributed at a cost not exceeding $600, thus effecting a saving of at least $1,000 annually over the old method.

The purchase of the property selected for the station at Tupelo, Miss., was consummated in August, 1902, when a topographical survey was made and the proposed improvements laid out. Construction work was begun February 21, 1903, and at the close of the year 11 artesian wells 400 feet deep had been bored and 2 large ponds of over 3 acres in area were nearing completion. The wells furnish a little over 80 gallons of water per minute, of a temperature of 63° F.

An acre of land adjoining the property at the Put-in Bay, Ohio, station was purchased in May, 1903, of the Independent Ice Company at a cost of $500, for the purpose of erecting a superintendent's residence thereon.

For the purpose of increasing and protecting the water supply at the Duluth, Minn., station, two lots which adjoin the property were purchased of the Lake Side Land Company on June 20, at a cost of $1,000.

Bills for numerous new hatcheries in various parts of the country have been introduced in Congress and referred to the Commission for recommendation. On most of these a favorable recommendation has been made. A feature of some of the bills, which is regarded as undesirable and which has been uniformly objected to, is the provision that a proposed hatchery shall be established at some particular point in a given state. To limit the Commission in this way may preclude the possibility of building a successful hatchery because of unsuitable topographical conditions and water supply, and is almost certain to involve a larger outlay for site and privileges than would otherwise be required.

ECONOMIC ASPECTS OF NATIONAL FISH CULTURE AND ACCLIMATIZATION.[a]

The question is often asked, "Does government fish-culture pay?" or, "Are the economic results of national fish-culture commensurate with the cost?" The people who entertain doubts on this point are mostly those who have not taken the time or had the opportunity to familiarize themselves with what has been attempted and what has been accomplished by the national and state fish commissions.

Much evidence can be adduced to show that the fish-cultural operation of the general government are of direct financial benefit to the country at large. The results, in the case of some species, have been so striking and so widespread that it would be almost as supererogatory to refer to them as to discuss the utility of agriculture; in the case of other species there can be no doubt of the value of the work, although it may be only occasionally possible to distinguish the effects of human intervention on the fish supply from those due to natural causes. Some of the important results of the Commission's efforts, which have previously been cited in the reports, may appropriately be again referred to, if only to draw attention to the continuance of the results.

The leading river fish of the eastern seaboard is the shad. No other anadromous species has been more extensively cultivated and none is now so dependent on artificial measures for its perpetuation. Inasmuch as the principal fisheries are in interstate or coastal waters and the movements of the fish fróm the high seas to our rivers and back to the high seas place it beyond the claim to ownership which might be urged by the various states were the shad a permanent resident within their jurisdiction, it has seemed especially desirable and necessary that this species should be fostered by the general government for the benefit of the entire country. The shad was one of the first species whose artificial propagation was taken up by the Fish Commission, and its cultivation is to-day a leading factor in fishery work. Almost every large shad stream has been the site of hatching operations, and during

[a] Extract from a lecture by Hugh M. Smith, deputy commissioner, entitled "How the Government maintains the fish supply," delivered before the Geographical Society of Baltimore, January, 1903.

the ten years ending in 1903 the number of artificially hatched shad returned to public waters by the government was over one and a half billion. An important point is that these eggs are taken from fish that have been caught for market, and hence would be totally lost if the Commission did not collect them from the fishermen.

The great multiplication of all kinds of fishing appliances on the coast, in the bays, in the estuaries, and along the courses of the rivers results in the capture of a very large part of the run each season before the shad reach the spawning grounds, and hence the natural increase is seriously curtailed, and, in some streams, almost entirely prevented. The steady increase in the shad catch in the face of conditions more unfavorable than confront any other fish of our eastern rivers is conclusive evidence of the beneficial effects of artificial propagation. In 1880, prior to which year shad cultivation had been on a comparatively small basis, the total yield of this species from Maine to Florida was 18,000,000 pounds; during the four succeeding years the supply in many of the streams decreased to such an extent that the abandonment of the fishery, as a commercial enterprise, was imminent. From 1885, when the largely-increased plants of fry began to produce results, until the present time, the trend of the fishery has been steadily upward in every stream. Against a product of 18,000,000 pounds, worth $995,000, in 1880, is to be placed an annual catch of over 50,000,000 pounds, valued at $1,700,000, at the present time. As a result of the increased abundance of shad, the cost of this toothsome food has been materially reduced, but even at the price actually received the value of the increase in the annual catch at this time is upward of a million dollars, or more than three times the amount expended by the government in the propagation of shad in twenty years.

Evidence is not lacking to show that the long-continued and increasingly extensive fish-cultural operations on the Great Lakes have prevented the depletion of those waters in the face of the most exhausting lake fisheries in the world. The luscious white-fish, the splendid lake trout, the excellent pike perch, or wall-eyed pike, are hatched in such numbers as to assure their preservation without further curtailing the fisheries.

The magnitude of the salmon fisheries of the Pacific States has required very extensive artificial measures to keep up the supply. Hatcheries have been established on tributaries of the Sacramento and Columbia, in the Puget Sound region, and on some of the short coast rivers; here are taken the eggs of the royal chinook, of the scarcely less royal blue-back, and of other species, and here each year millions of young salmon are started on their way to salt water. Having grown and waxed fat on the rich pasturage of the ocean, these fish return to the rivers to spawn in from two to four years. Some seasons as many

as 75,000,000 salmon eggs have been collected, a quantity representing nearly 21,000 quarts, or 650 bushels.

A remarkable fact in the history of the Pacific salmons—of which there are five species—is that without exception all fish which enter any stream on the entire coast, from the Golden Gate to the Arctic Ocean, die after once spawning, none surviving to return to the sea. This wise provision of nature to prevent the overstocking of streams has been made foolish by the appearance of man on the scene; he not only catches the salmon in the coast waters and the lower courses of the rivers with gill nets, seines, and pound nets, in the upper waters with the same appliances supplemented by the fish wheels, and on the spawning grounds with all sorts of contrivances, but in certain sections even carries his foolhardy greed to the extent of barricading the streams so that no fish can reach the waters where their eggs must be deposited.

Natural reproduction, thus so seriously curtailed, is not sufficient to keep up the supply in many of the streams where fishing is most active, for many of the eggs escape fertilization, many more are eaten by the swarms of predaceous fishes that haunt the spawning beds, and many are lost in various other ways during the long hatching period; while the helpless fry and alevin fall a ready prey to the same fishes in the upper waters and the young salmon have to run the long gauntlet of the rivers only to meet new foes in the estuaries, on the coast, and in the open sea.

It is, therefore, no wonder that artificial propagation on a large scale is imperatively demanded in the western salmon streams, and is actively urged and highly commended by fishermen, canners, business men, and the public at large. The beneficial influence of the work of the government, supplemented by that of the three coast states, has been unmistakable in some sections and can not be doubted in general; but it has not often been possible to distinguish definitely the increase due to natural from that due to artificial propagation; recently, however, some striking evidence of the benefits arising from the hatchery operations has come from the experimental marking of young salmon before liberation. Thus, a lot of 5,000 fingerlings incubated at the Clackamas (Oregon) station in 1896 were released after being marked in such a way that they could be recognized if again caught. In 1898 375 of these marked fish, averaging 27 pounds, were caught in the Columbia and 5 in the Sacramento, and in the two following seasons probably 70 more were taken, the aggregate weight of the salmon known to have been recaptured being not less than 10,000 pounds.

The outcome of this experiment is of extraordinary significance. It means that for every thousand fingerling salmon hatched and liberated by the Fish Commission on the Columbia, 2,000 pounds of adult fish were caught for market two, three, and four years later. Let us

reduce this to a financial basis and see what a striking exhibit is made: The total expense to the government of hatching and planting salmon is under $1 per thousand fish of the size in question; the value of the resulting salmon caught by the fisherman is, at a very reasonable estimate, 5 cents per pound, or $100 for the 2,000 pounds actually taken. It is not claimed or expected that such extraordinary results are regularly attained, but, if the average outcome is only one-tenth as large as shown by these figures, then the salmon work of the Commission is yielding an actual money return of 1,000 per cent per annum.

Man's possible influence on the fishes of the open sea is problematical, but there is no doubt of the effects of human intervention on the abundance of fishes and other animals which regularly frequent the bays and coastal waters, more especially the bottom-living species like the cod, the flounders, and the lobster, which are hatched in large numbers at the marine establishments of the Commission. The utility of fish culture as applied to the cod is scouted by some people in the United States and abroad; singularly enough, however, some of these same people are willing to admit the injury done by overfishing or indiscriminate fishing.

In taking up the culture of the cod many years ago, and in continuing it to the present time, the Fish Commission has proceeded on the principle that the effects of man's improvidence may be counteracted by the application of man's ingenuity and power in aiding nature. The ultimate success of cod culture on the Atlantic coast was therefore confidently expected, and the expectations have been more than realized. Practical results of an unmistakable character were first manifested in 1889, since which time a very lucrative shore cod fishery has been kept up on grounds that were entirely depleted or that had never contained cod in noteworthy numbers in the memory of the oldest inhabitants. There is much unsolicited testimony on this point from many people who have profited from the past twelve or fifteen years' operations at Gloucester and Woods Hole stations. The benefits have not been confined to the immediate vicinity of the hatcheries, but have extended westward and southward along the Middle Atlantic coast and eastward along the whole coast of Maine.

A very important line of practical work conducted by the Commission is the transplanting of aquatic food animals into waters to which they were not indigenous. This work is addressed not only to lake, pond, and stream fishes like the basses and trouts, but also to the sea-going species like the salmon, shad, and striped bass. Examples of the results of such efforts have been published in the annual reports from year to year, and some further data will appear elsewhere in the current report; but attention is particularly drawn to two of the most successful instances of acclimatization of native fishes. About thirty years ago the shad and the striped bass of the Atlantic coast were

introduced on the Pacific coast; the slender colonies became established, flourished, extended themselves widely, and multiplied to such an extent that these two species now rank among the leading food fishes of the Pacific States, and in certain localities exist perhaps in greater abundance than in any waters on the Atlantic coast. The economic results of what was at first only an experiment may be thus stated:

Total cost of planting shad and striped bass on Pacific coast, under	$5,000
Average annual catch of these fish at present time ... pounds	2,500,000
Yearly market value of the catch	$100,000
Aggregate catch to end of 1902 ... pounds	18,900,000
Total value of the catch to end of 1902	$670,000

BIOLOGICAL INVESTIGATIONS.

The work of that branch of the Commission charged with the inquiry respecting food-fishes and the fishing grounds has for its immediate object the application of the principles of biological science to the practical problems which arise in connection with the commercial fisheries and fish culture. The operations of this division, as outlined in the special report appended hereto, cover a wide range and are addressed to some of the most valuable economic products of the water and to some of the most vital matters affecting the fishing industry and the cultivation of fish.

The oyster has deservedly received a great amount of attention. Further progress has been made in interesting experiments having for their object the fattening of oysters by increasing their natural food. Oyster culture in Japan is the subject of a timely special report issued during the year, for which there has been a large demand in view of the proposed cultivation of Japanese oysters in the Pacific States. The lobster, the blue crab, the diamond-back terrapin, the Atlantic and Pacific salmons, the carp, the catfishes, the tile-fish, and the commercial sponges of Florida have been objects of special investigation. In the case of the last named, the sponge grounds lying off the east coast of Florida have been surveyed and plotted, and very important experiments in the growing of sponges from cuttings have been conducted.

At the direction of the President, a special commission was formed for the purpose of making an investigation of the salmon industry of Alaska, the main objects being to determine the actual fishery conditions in different parts of the territory and to make such recommendations as seem necessary to regulate the fishery and preserve the supply of salmon. The extraordinarily large increase in the salmon catch in recent years has led to the belief that there would be serious depletion of the salmon streams unless more effective restrictions were imposed. Dr. David S. Jordan was selected as head of the commission, and plans were made for a very thorough canvass of the entire subject.

The investigation of the aquatic resources of the Hawaiian Islands, which had been in progress during the previous fiscal year, was continued and concluded; and in conjunction therewith an examination of the fish fauna of the Samoan Islands was undertaken.

The marine biological laboratories at Woods Hole, Mass., and Beaufort, N. C., have been resorted to by many investigators, and much important research work has been carried on.

In view of the important rank attained by the Japanese in fishery matters, it was deemed advisable to conduct an inquiry which would acquaint the Commission with the general condition and methods of the fisheries of Japan and afford information in regard to a number of branches in which Americans are practically interested and in which the Japanese are preeminent. Dr. H. M. Smith was assigned to this inquiry, which was in progress at the close of the year. Among the subjects specially considered were the utilization of seaweeds, the culture of terrapin, the artificial production of pearls, and the habits, food value, etc., of the dwarf salmon with a view to its introduction into the United States.

STATISTICS AND METHODS OF THE FISHERIES.

The importance of showing from time to time, by accurate statistics, the extent and trend of the fisheries need not be emphasized. The small sums devoted to this work in the Commission are well expended and should be increased in order to permit a more frequent canvass of the entire country than is now possible. During the year detailed statistics of the entire fishing industry of the Middle Atlantic, South Atlantic, and Gulf States were gathered; and a number of statistical inquiries addressed to special states or territories were also taken up, including Colorado, Alaska, and Porto Rico. The collection of statistical information showing the receipts of fish at the ports of Boston and Gloucester has continued, and the monthly bulletins based thereon furnish much useful information to the trade. Special branches which have been canvassed are the mackerel fishery of New England, the salmon fishery of Penobscot Bay and River, and the salmon industry of Alaska in connection with the work of the Alaska salmon commission elsewhere alluded to.

OPERATIONS OF VESSELS.

Steamer Albatross.—This vessel returned to San Francisco from the Hawaiian Islands on August 30 having been absent 173 days, of which 122 were spent in work at sea, and 36 at work in port, the remainder being Sundays and holidays. Four hundred dredging and collecting stations were established, a record which has never been exceeded by the *Albatross.* The investigations at the islands were carried on among the channels and on surrounding banks, and

included the tracing of the size and shape of the insular shelf out to the 1,000-fathom curve; and the survey was extended westward along the chain of reefs and islets which reach out from the main group in the direction of Japan. The vessel went as far westward as Laysan Island, where collections of fishes and other aquatic animals were made, and opportunity was afforded for observation and study of the vast rookeries of albatrosses and other sea birds which breed upon this small island. On the return from Laysan visits were made to several other islets, including French Island, Frigate Shoal, Necker Island, and Bird Island, and valuable collections were secured.

The results of the dredging and other operations were exceedingly prolific, and have added largely to the knowledge of the aquatic fauna of the Hawaiian Islands. As opportunity offered, hydrographic notes, with charts and sailing directions, were made by the ship's officers and transmitted to the United States Coast and Geodetic Survey. A full report of the expedition and of what was accomplished thereby is now in course of preparation.

The amount of hard cruising the ship had been called on to perform made it necessary to give her a thorough overhauling as to both hull and machinery, the latter, especially, requiring considerable repairs and alterations, and a new electric plant and searchlights being needed. Congress provided for this purpose a special appropriation, approved March 5, and the work was undertaken at once and completed June 11.

By direction of the President, a special commission, with Dr. David Starr Jordan as executive head, was appointed by the Commissioner to make investigations concerning the condition and needs of the Alaska salmon fisheries, and as these investigations necessitated visits to the numerous remote salmon streams and canneries and salteries in Alaska, the *Albatross* was detailed for the use of the commission. The ship sailed on June 11 from San Francisco for Seattle, whence, after having been joined by the various members of the party, she proceeded northward June 18. The next few days were devoted to dredging at various places in Georgia Strait and Queen Charlotte Sound.

February 12, 1903, Commander Chauncey Thomas, U. S. Navy, who had been in command of the *Albatross* somewhat over a year, during which he displayed great efficiency, was detached by order of the Secretary of the Navy, and was succeeded by Lieut. Franklin Swift, U. S. Navy, retired, formerly in command of the steamer *Fish Hawk*.

Steamer Fish Hawk.—During the months of July, August, and September the *Fish Hawk* was detailed for biological work in connection with the laboratory at Beaufort, N. C. Five lines of soundings and dredgings were made at right angles to the trend of the coast out to the inner margin of the Gulf Stream, to develop the character of the fauna of the region and to determine the possibility of establish-

ing deep-water fisheries in that locality. Though interruptions were experienced from severe winds, considerable progress was made. The region covered consists of a hard sandy bottom with little animal life, and on the edge of the Gulf Stream a scarcity of life was observable. About 20 miles south-southwest of Beaufort, however, an important fishing ground was located and surveyed; fishing trials showed an abundance of sea bass and other desirable food fishes.

At the close of the season at the Beaufort laboratory, after undergoing necessary repairs at Savannah, the vessel sailed from that port November 22 for Key West, Fla., to continue her previous work on the sponge grounds of Florida. The scope of this is outlined in the last report, and this year the investigation embraced the keys from Boco Grande Channel to Cape Florida, and the "New Ground" extending north of the keys to Cape Sable. Work was begun December 4, lines of soundings and dredging being run over the region to be developed, with stations every 3 miles out to the 5-fathom curve. All classes of sponges are found on the New Ground, and good fares are taken when the fishermen can find the water sufficiently clear to work. The ground to the southeast of Cape Sable is considered good, but there are considerable expanses of barren sandy bottom. The investigations were continued along the known sponge grounds among the keys and channels eastward to Cape Florida. These were completed March 12, when lines of soundings and dredgings were begun off shore in the vicinity of Fowey Rocks and Cape Florida to determine the character of the fauna of that region and on the edge of the Gulf Stream. These investigations were not completed when it became necessary for the vessel to proceed north to take up the usual shad hatching on the Delaware River. She sailed from Miami April 6, arriving at Gloucester City, N. J., April 16. The shad work continued till June 19.

In order to remedy defects incident to the wear and tear of long service, considerable repairs to the machinery were found advisable, including the installation of new pumps; and certain parts of the decks and beams needed to be replaced. This work is now in progress and will add to the efficiency of the vessel and the economy of operating her.

The *Fish Hawk* has continued under the command of Boatswain J. A. Smith, U. S. Navy, retired, whose long and faithful service on the vessel has been invaluable to the Commission.

Schooner Grampus.—The *Grampus* is an important adjunct of the marine fish-cultural operations in New England, and under the efficient command of Mr. E. E. Hahn has rendered most valuable service under conditions involving much discomfort and exposure. During the early part of the fiscal year this vessel was engaged in collecting egg-bearing lobsters on the Maine coast to supply the hatchery at Glou-

cester, Mass. At the conclusion of the lobster work she proceeded to Woods Hole and was there employed for a while during the summer in connection with the biological laboratory. In the fall of 1902 the vessel made the usual trips to Nantucket Shoals to obtain brood codfish for the Woods Hole station, and later the crew proceeded to Maine for the purpose of gathering cod eggs for the Gloucester hatchery. In the spring the *Grampus* resumed the collecting of brood lobsters on the coast of Maine and was thus engaged at the close of the year.

MISCELLANEOUS.

CHANGES IN PERSONNEL.

The position of deputy commissioner, created at the last session of Congress, was filled by the appointment of Dr. Hugh M. Smith, to take effect July 1, 1903. Doctor Smith held the position of assistant in charge of scientific inquiry from January, 1897, until June 30, 1903, and prior to that service was assistant in charge of statistics and methods of the fisheries for a period of four years.

The Commission regrets the loss of the services of Mr. Charles H. Townsend, assistant in charge of statistics and methods of the fisheries, who on November 11, 1902, resigned to become director of the New York Aquarium. Mr. Townsend entered the Commission as scientific assistant in 1883, and for many years prior to his appointment as chief of division was naturalist on the *Albatross*. In addition to his other duties, Mr. Townsend was prominently identified with the fur-seal investigations in the North Pacific Ocean and Bering Sea, under the direction of the Treasury Department.

Dr. Barton W. Evermann, principal scientific assistant, was, on November 13, 1902, appointed to the position made vacant by Mr. Townsend's withdrawal from the service, and was subsequently appointed assistant in charge of scientific inquiry, to take effect July 1, 1903.

The position of scientific assistant, vacated by Doctor Evermann, was filled by the promotion, on November 17, 1902, of Dr. H. F. Moore, naturalist on the *Albatross*, who, on November 19, 1902, was succeeded as naturalist by Mr. Cloudsley Rutter, scientific assistant.

The position of assistant in charge of statistics and methods of the fisheries was filled by the appointment of Mr. A. B. Alexander, fishery expert on the *Albatross*, to take effect July 1, 1903.

The propagation and distribution of food-fishes have continued under the supervision of Mr. John W. Titcomb. Mr. J. Frank Ellis, who for many years has been superintendent of the car and messenger service, has remained in immediate charge of that branch.

PUBLICATIONS.

During the year there have been added to the library 164 bound volumes and 466 unbound volumes and pamphlets. The bound report for 1901 and the bound bulletins for 1900 and 1901 have been issued, besides the following extracts in pamphlet form from the report and bulletin for 1902:

Description of a new species of shad (*Alosa ohiensis*), with notes on other food fishes of the Ohio River, by Barton Warren Evermann. Report for 1901, pp. 273–288. 1902.

The reproductive period in the lobster, by Francis H. Herrick. Bulletin for 1901, pp. 161–166. 1902.

Notes on five food fishes of Lake Buhi, Luzon, Philippine Islands, by Hugh M. Smith. Bulletin for 1901, pp. 167–171, plate 22. 1902.

Marine protozoa from Woods Hole, by Gary N. Calkins. Bulletin for 1901, pp. 413–468. 1902.

Notes on a species of barnacle (*Dichelaspis*) parasitic on the gills of edible crabs, by Robert E. Coker. Bulletin for 1901, pp. 399–412. 1902.

The fishes and fisheries of the Hawaiian Islands. A preliminary report, by David Starr Jordan and Barton Warren Evermann. Commercial fisheries of the Hawaiian Islands, by John N. Cobb. Report for 1901, pp. 353–499, plates 21–27. 1902.

Notes on the fisheries of the Pacific coast in 1899, by William A. Wilcox. Report for 1901, pp. 501–574, plates 28, 29. 1902.

Statistics of the fisheries of the Great Lakes. Report for 1901, pp. 575–657. 1902.

Statistics of the fisheries of the Mississippi River and tributaries. Report for 1901, pp. 659–740. 1902.

The Pan-American Exposition. Report of the representative of the U. S. Fish Commission, by W. de C. Ravenel. Report for 1901, pp. 289–351, plates 6–20. 1902.

Notes on the boats, apparatus, and fishing methods employed by the natives of the South Sea Islands, and the results of fishing trials by the *Albatross*, by A. B. Alexander. Report for 1901, pp. 741–829, plates 30–37. 1902.

The salmon and salmon fisheries of Alaska. Report of the Alaskan salmon investigations of the United States Fish Commission steamer *Albatross* in 1900 and 1901, by Jefferson F. Moser. Bulletin for 1901, pp. 173–398 and 399–401, plates I–XLIV, plate A, and charts A, B. 1902.

Observations on the herring fisheries of England, Scotland, and Holland, by Hugh M. Smith. Bulletin for 1902, pp. 1–16, plates 1 and 2. 1903.

Japanese oyster culture, by Bashford Dean. Bulletin for 1902, pp. 17–37, plates 3–7. 1903.

The habits and culture of the black bass, by Dwight Lydell. Bulletin for 1902, pp. 39–44, plate 8. 1903.

Hearing and allied senses in fishes, by G. H. Parker. Bulletin for 1902, pp. 45–64, plate 9. 1903.

Natural history of the quinnat salmon. A report on investigations in the Sacramento River, 1896–1901, by Cloudsley Rutter. Bulletin for 1902, pp. 65–141, plates 10–18. 1903.

Notes on fishes from streams and lakes of northeastern California not tributary to the Sacramento Basin, by Cloudsley Rutter. Bulletin for 1902, pp. 145–148. 1903.

Breeding habits of the yellow cat-fish, by Hugh M. Smith and L. G. Harron. Bulletin for 1902, pp. 151–154. 1903.

The destruction of trout fry by hydra, by A. E. Beardsley. Bulletin for 1902, pp. 157–160. 1903.

Descriptions of new genera and species of fishes from the Hawaiian Islands, by David Starr Jordan and Barton Warren Evermann. Bulletin for 1902, pp. 161–208. 1903.

Report of the Commissioner for the year ending June 30, 1902, including the reports of divisions of fish culture, scientific inquiry, and fisheries. Report for 1902, pp. 1–160, plates 1–5. 1903.

There were distributed during the year 3,087 bound and 18,250 pamphlet publications of the Commission. The demand for publications

is increasing yearly, and it has been necessary to have reprinted certain of the more popular and useful pamphlets.

The Museum of Comparative Zoology, Cambridge, Mass., has published, under the general title, "Reports on the scientific results of the expedition to the tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission steamer *Albatross*, from August, 1899, to March, 1900, Commander Jefferson F. Moser, commanding:"

The coral reefs of the tropical Pacific. By Alexander Agassiz. (Vol. XXVIII. February, 1903.)

Sharks' teeth and cetacean bones from the red clay of the tropical Pacific. By C. R. Eastman. (Vol. XXVI, No. 4. June, 1903.)

THE AMERICAN FISHERIES SOCIETY.

This society includes in its membership most of the persons engaged in practical fish culture in the United States and, in addition, many of those interested in biological, economic, and administrative work in connection with the fisheries. The yearly meetings, held in different parts of the country, are well attended and greatly promote the interests of fish culture and the fisheries. The annual meeting for 1902–3 was held at Put-in Bay, Ohio, August 5 to 7, 1902, Gen. E. E. Bryant, of the Wisconsin Fish Commission, presiding. Among the papers presented and discussed were the following:

The habits and culture of the black bass. By Dwight Lydell, of the Michigan Fish Commission.

Discouragements in bass culture. By H. D. Dean, of the United States Fish Commission.

Some remarks on the rainbow trout, the time for planting, etc. By George A. Seagle, of the United States Fish Commission.

Fish culture on the farm. By J. J. Stranahan, of the United States Fish Commission.

Artificial feeding of trout; its effect on growth and egg production. By W. T. Thompson, of the United States Fish Commission.

The brook-trout disease and cement ponds. By M. C. Marsh, of the United States Fish Commission.

A successful year in the artificial propagation of the white-fish. By Frank N. Clark, of the United States Fish Commission.

The role of the larger aquatic plants in the biology of fresh water. By Raymond H. Pond, of the University of Michigan.

Food and game fishes of the Rocky Mountain region. By James A. Henshall, of the United States Fish Commission.

For the ensuing term George M. Bowers, United States Fish Commissioner, was elected president, and the place selected for the next meeting was the United States Fish Commission station at Woods Hole, Mass.

M'DONALD PATENTS.

By an act of Congress approved February 14, 1902, the Secretary of the Treasury was directed to purchase from the owners of the McDonald hatching jar all their rights in and the patents on this apparatus for the United States, and the same act provided for the purchase from the estate of the late Commissioner McDonald, for the use of the government, the rights and patents pertaining to all fish-cultural apparatus and appliances invented by him.

APPROPRIATIONS.

The appropriations for the Commission for the fiscal year 1903 were as follows:

Salaries	$241,140
Miscellaneous expenses:	
Administration	12,500
Propagation of food fishes	175,000
Inquiry respecting food fishes	22,500
Statistical inquiry	7,500
Maintenance of vessels	36,000
For repairs to buildings in Washington	3,000
For surfboat for steamer *Albatross*	500
For steam boiler at Woods Hole, Mass	2,000
For purchase of site for station at Tupelo, Miss	2,000
For purchase of additional land, for improvements, and for completion of stations at—	
Erwin, Tenn	5,000
San Marcos, Tex	2,500
Green Lake, Me	4,000
Gloucester, Mass	2,500
Duluth, Minn	2,000
Beaufort, N. C. (biological laboratory)	12,500

A report of the expenditures under these appropriations will be made to Congress, in accordance with law.

GENERAL CONDITION OF THE FISHERIES.

The commercial fisheries of the United States, excluding insular possessions, are now more valuable than those of any other country. Some of the leading branches are peculiar to this country, and contribute largely to the importance of its fishing industry, while in others, which are common to many lands, the United States is preeminent or has prominent rank.

The condition of the fishing industry during the year 1903 was on the whole prosperous. While the great commercial fisheries are subject to seasonal fluctuations, there has been no indication of a permanent downward tendency except in a few cases, in some of which improvement may be effected by artificial propagation.

From data collected by the Commission, it appears that the number of persons directly engaged in the fishing industry at this time is about 213,000, of whom 155,000 are fishermen and 58,000 are shoresmen and employees of fishing and fish-curing establishments. The aggregate capital invested is about $76,850,000, of which $13,450,000 represent vessels, $4,530,000 boats, $8,220,000 apparatus of capture, and the remainder shore and accessory property and cash capital. The 6,340 registered vessels employed in fishing have a net tonnage of 172,400. The value of the catch at first hands is $49,882,000, of which the ocean and coast fisheries represent $44,964,000 and the Great Lakes and other interior fisheries $4,918,000.

The ocean fisheries of New England, which have always been the most important of their class, have been in a satisfactory condition.

At the two great fishing ports of Gloucester and Boston the quantity of fish landed by American fishing vessels in 1902 was about 168,000,000 pounds, valued at $4,380,000, an increase of 17,000,000 pounds and $130,000 as compared with 1901. The mackerel catch has never since reached the proportions attained in the years preceding 1887, although it is now greatly in excess of the product during the first half of the present period of unprecedented scarcity. The tendency of late has been upward, and it is believed that in a comparatively few years the mackerel will have again become abundant on our shores.

The condition of the lobster fishery has been practically unchanged for several years, although it can not be doubted that the tendency is downward. The catch fluctuates somewhat from year to year, and certain localities may show a decided increase; but if the general output in a state is greater in one year than another, the cause may usually be found in the fact that the fishery was prosecuted for a longer time, or that more men and more apparatus were employed. It seems very improbable that there will be any general improvement in the fishery until new methods of conducting it are adopted and shall have continued for a number of years. Uniform protective laws are greatly needed, and without them the work of the Commission in lobster cultivation will have but little effect at this stage of the decline.

The oyster fishery is engaged in by more persons than any other branch and contributes nearly one-third of the annual value of the United States fisheries. A very satisfactory feature of this industry during recent years has been the increased interest manifested in oyster culture, more especially in the Middle Atlantic region, where the most beneficent results may be expected to follow the adoption of proper laws for the promotion of oyster planting.

The Pacific salmon industry in 1902 reached larger proportions than ever before, and became the leading branch of the United States fisheries, if the value of the product as prepared for market is considered. The pack of canned salmon was more than 3,500,000 cases of 48 one-pound cans, and in addition upward of 42,000,000 pounds of fresh, smoked, and salted salmon were marketed. The pack of canned salmon in Alaska was over 2,500,000 cases, an increase of half a million cases over 1901. In the Puget Sound region the supply of fish was much smaller than in the previous year, but the season was considered successful owing to the good prices received. The fall run of salmon in Columbia River was remarkably large, and for a period of three weeks the canneries were unable to handle the catch. At some of the seine fisheries 20 tons of chinook salmon were sometimes taken in one day, and the gill-net fishermen had no difficulty in loading their boats in a night. From a careful computation made by the Commission, it appears that in 1902 the wonderful Pacific salmon fisheries yielded about 280,000,000 pounds of round fish whose first value, as placed on the markets, was $18,000,000.

A RETROSPECT.

With the current report, the existence of the Commission as an independent establishment of the government ceases, for on July 1, 1903, the Commission became a part of the new Department of Commerce and Labor, under the terms of the act of Congress approved February 14, 1903. While it can not be doubted that the changed status will prove most beneficial to the Commission, it is felt that its entire record as an independent institution has been so extremely creditable that the best wish that can be entertained for it is that under the new conditions it may continue to receive the liberal support which has heretofore been accorded, and that its operations and influence may increase in the same ratio that has characterized recent years.

The joint resolution of February 9, 1871, by which Congress established the Commission, provided only for an inquiry into the decrease of food fishes, with a view of adopting any remedial measures that seemed necessary, and appropriated $5,000 therefor. During the next ten years the sums devoted to the operations of the Commission remained comparatively small, but through the energy and ability of the Commissioner, Prof. Spencer F. Baird, with the assistance of several of the executive departments, the work steadily increased and its scope was extended. The early inquiries conducted by the Commission showed that artificial propagation was the most effective form of aid which the federal government could render the commercial fisheries, and artificial propagation quickly became and has remained the key-note of the Commission's efforts. So efficiently did the Commission labor in devising fish-cultural methods and in applying them to the practical work of maintaining and increasing the supply of food fishes that at the International Fisheries Exhibition held in Berlin in 1880 the grand prize was awarded to Professor Baird as "the first fish culturist in the world," and at the International Fisheries Exhibition held in London in 1883 Professor Huxley said that he "did not think that any nation at the present time had comprehended the question of dealing with fish in so thorough, excellent, and scientific a spirit as the United States."

Owing to the liberal policy of Congress in recognizing the importance of the fishery work and in providing for its development, the growth of the Commission in the past twenty-five years has been phenomenally rapid, not only in fish culture, but in biological investigation addressed primarily to fish culture and the fisheries, in the study of the methods and relations of the fisheries, and in the gathering and presentation of statistical information covering all phases of the fishing industry. The Commission at an early date became one of the most popular of the government bureaus, and its popularity has increased yearly as its work has become more thoroughly understood and as the practical results of its operations have multiplied.

It may not be inappropriate, in concluding this report, to show the magnitude of the Commission's work in artificial propagation and to indicate the growth of this work from the year 1871 to the present time. The following table shows the number of eggs, fry, yearlings, and adults of each of the more important species distributed by the Commission during the thirty-three years of its existence, the time being divided into three periods of eleven years each. The aggregate output is seen to have been over 12 billions, more than three-fourths of which represent the operations of the past eleven years. The seven species which have received the most attention—namely, the shad, the quinnat salmon, the white-fish, the pike perch, the cod, the winter flounder, and the lobster—are of great economic value, and their aggregate output has been more than 90 per cent of the total.

Table showing the number of adult fish, yearlings, fry, and eggs distributed by the United States Fish Commission, 1871–1903.

Species.	1871–1881.	1882–1892.	1892–1903.	Total.
Shad	200,946,350	767,697,000	1,532,984,284	2,501,627,634
Alewives	9,833,000	6,850,000		16,683,000
Striped bass	400,000	385,587	3,575,000	4,360,587
Sea bass		3,654,000	2,302,000	5,956,000
White perch	180,000	2,573	31,308,000	31,490,573
Quinnat salmon	33,172,734	29,152,195	313,105,847	375,430,776
Blueback salmon			21,620,242	21,620,242
Silver salmon			3,682,144	3,682,144
Atlantic salmon	12,524,387	11,552,864	12,731,850	36,809,101
Landlocked salmon	6,414,961	5,284,275	4,856,038	16,555,274
Steelhead trout			6,704,101	6,704,101
Loch Leven trout		677,083	938,624	1,615,707
Rainbow trout	116,830	2,888,224	8,922,794	11,927,848
Black-spotted trout		19,000	8,411,270	8,430,270
Brook trout	100,700	1,926,328	30,487,424	32,514,452
Brown trout		904,081	538,491	1,442,572
Scotch sea trout			158,829	158,829
Golden trout		54,473	165,918	220,391
Lake trout	40,606	14,638,967	170,878,420	185,557,993
White-fish	77,072,409	928,215,000	2,330,355,335	3,335,642,744
Lake herring			126,447,000	126,447,000
Grayling			13,931,630	13,931,630
Smelt		13,850,000		13,850,000
Pike perch		332,046,700	1,565,604,761	1,897,651,461
Yellow perch		830,328	30,431,694	31,262,022
Black bass		122,666	1,840,040	1,962,706
Crappies, sun-fishes, etc		154,175	2,874,466	3,033,641
Carps and suckers		1,738,350	780,082	2,518,432
Cod	25,000	178,216,500	1,451,158,500	1,629,399,500
Tomcod		5,400,000		5,400,000
Pollock		39,458,500	5,289,000	44,747,500
Haddock		5,799,000	19,500	5,818,500
Scup		431,000	280,000	711,000
Sheepshead		7,300,000		7,300,000
Tautog		362,000	24,066,000	24,428,000
Squeteague		227,000		227,000
Cat-fish			337,673	337,673
Mackerel		688,000	3,309,000	3,997,000
Spanish mackerel	270,000	1,026,000		1,296,000
Flat-fish		13,932,019	717,271,000	731,203,019
Miscellaneous fishes		64,875	91,124	156,703
Lobster		15,835,647	863,547,065	879,382,712
Total	341,096,977	2,391,389,410	9,291,005,146	12,023,491,533
Annual average	31,008,816	217,399,037	844,636,831	

GEORGE M. BOWERS,
Commissioner.

REPORT ON THE PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

By John W. Titcomb, *Assistant in Charge.*

The division of fish culture is charged with the artificial propagation of fishes, the rescue of fishes from overflowed lands of the Mississippi and Illinois rivers, the distribution of fish and eggs, and the stocking of public and private waters with suitable food and game fishes.

The demand for fish is now greater than ever before. The number of applications received during 1903 was 4,315—an increase of 13 per cent over 1902 and of 41 per cent over 1901. A large proportion of these applications was from anglers or sportsmen, and called for such fishes as the basses, trouts, and salmons. The total output of the hatcheries was 1,226,057,457 fish and eggs, of which 14,381,866 were the species commonly classed as game, while 1,211,675,609 were those species which enter into the commercial fisheries of the country.

While the same general methods of fish culture have been followed as heretofore, a few changes have been made in the handling of certain fishes. Thus at the various stations where bass are propagated, where heretofore all the fish have been reared for fall distribution as fingerlings, a large number of fish this season were distributed as "baby fingerlings." This term has been applied by fish culturists to fish 1 to 3 inches long taken from the ponds in May, June, and July. It has been found that there is such a difference in the size of the fish in the early and late broods that some measures are necessary for the disposition of the fish last hatched in order to prevent their destruction by the larger fish. In connection with the stripping and fertilizing of the eggs of the Pacific salmons, the normal salt solution has been more extensively used than heretofore; and some experiments at the Clackamas station have tended to indicate that a larger percentage of eggs can be fertilized by cutting the fish open, removing all the eggs, and washing them in the salt solution, than by the usual method of stripping.

At some of the stations it has been found that eggs can at times be purchased from private fish culturists at less expense than they can be collected from wild fish. In purchasing, care is taken to secure eggs of fish not less than two and one-half years old, it having been proved

that the eggs from the second year's stripping are preferable to those of younger fish. For a comparison of methods, during the past year the eggs from six private hatcheries were placed side by side in troughs at the various stations and incubated under similar conditions of water supply. It was found that there is a great difference in the quality of eggs received from different hatcheries, undoubtedly due to the condition of the parent fish, which at some stations may be crowded and overfed. Where extensive purchases of eggs are made the cost of transportation is an item for consideration, and in this connection it is noted that the nature of the material in which the eggs are packed has much to do with the cost of transportation. Where dried forest leaves are used the cost of shipment is about one-half the cost when sawdust is used. Dried leaves are the most desirable packing, but of the other materials used dried moss or shavings are preferable to sawdust.

As a result of special efforts to extend the work of propagating the Atlantic salmon, the output was nearly three times as great as in the previous year, and a larger number than usual was reared as fingerlings and yearlings.

The shad season was fairly successful, and 156,873,000 eggs were secured. Early in March the weather was unusually warm, causing the water temperature to rise, and attracting the shad to the rivers. At the Edenton, N. C., station, about the average collections were obtained, but at the station on the Potomac River the take of eggs was larger than ever before. A cold wave in April greatly retarded and interfered with operations on the Susquehanna and Delaware rivers, and the results at those stations were much less than had been anticipated.

The collection of lake trout eggs at the Great Lakes stations was the largest in the history of the Commission, the results being especially good on Lake Michigan, where a new station was established at Charlevoix. The egg collections amounted to 51,841,000, most of the eggs being taken during the closed season by means of tugs hired to secure the ripe fish, and the fry hatched from them were planted on the spawning grounds. Preparations were made for penning white-fish on an extended scale, but owing to warm weather during the spawning season the collections fell somewhat behind those of the previous year. The total number of eggs taken was 409,384,000, secured from the penned fish and from commercial fishermen operating in the various fields on Lake Erie and the Detroit River. Of these the state fish commissions were given 63,052,000; the remainder were hatched and the fry liberated in the waters from which the parent fish were obtained.

As in the past, the principal work of the Commission on the Pacific coast during the year has been the propagation of the quinnat salmon, operations being conducted at 11 stations located in California, Oregon,

and Washington, and resulting in the collection of 47,079,000 eggs, of which 13,142,000 were furnished to state fish commissions. The prospects for work were very bright early in the year, the run of fish being unusually large and necessitating the installation of extra racks at some points, but owing to high water during the spawning period many of the fish escaped over the racks, and in some of the rivers the dams and buildings were carried away, thus putting an end to what had promised a very profitable season. Fry and fingerlings of other species of salmon to the number of 4,730,000 were produced for distribution at these stations. Eggs of the white-fish, lake trout, brook trout, rainbow trout, black-spotted trout, and landlocked salmon were sent to the Clackamas station to be hatched, with a view to stocking the waters of the Pacific coast states, thereby saving the expense of transporting fish of these species from eastern stations.

The unseasonably warm weather in March and a sudden lowering of the temperature early in April caused a falling off in the pike perch work on Lake Erie, the total collection of eggs for the Put-in-Bay station amounting to 325,675,000, or over a hundred million less than in 1902. While they were still in the green stage, 70,000,000 eggs were shipped to various state commissions; the remainder were hatched and planted on the spawning grounds in Lake Erie. The pike perch work at Swanton, Vt., was also affected by the unfavorable weather, and though it had been planned to operate on a larger scale than in the past, the results at this point were smaller than ever before, only 50,000,000 eggs being secured. About 10,000,000 of these were furnished to state commissions and the fry hatched from the remaining eggs were distributed in the waters of Vermont and surrounding states.

Owing to scarcity of brood fish and other causes, the cod work at the Massachusetts stations was unusually light, only 152,582,000 eggs being secured at all points. On the other hand, the conditions governing the flatfish work were very favorable, and 328,060,000 eggs were taken and hatched with the usual small percentage of loss, the fry being distributed on the spawning grounds along the Massachusetts coast. At the Woods Hole station the cultivation of mackerel, sea bass, scup, and tautog has been resumed, and will be pushed as actively as practicable. There was a decided falling off in the lobster work, the stormy weather interfering greatly with the work in Maine, while nearly all of the fishing centers in Massachusetts showed a decreased catch. The 74,623,000 eggs obtained were hatched and the fry planted on the fishing grounds along the coast from Maine to Connecticut.

One of the best of the small river fishes is the yellow perch, which has become comparatively scarce in some localities on account of extensive fishing and absence of protection. The cultivation of the species is demanded, especially on the Potomac River, and has been taken up at several stations incidentally to other work. The output in 1903 was

about 30,000,000, and it is expected that much larger results will be obtained hereafter.

An equally important and excellent fish is the white perch, whose cultivation has now become desirable and was first conducted on a large scale in 1903. In connection with the propagation of shad on Susquehanna River, upward of 30,000,000 white perch fry were hatched and planted.

It would appear that regular operations addressed to the propagation of the striped bass may be practicable on Roanoke River, and that large numbers of this highly esteemed food and game fish may hereafter be produced. Experimental work at Weldon, on that stream, in the spring of 1903, resulted in the hatching of upward of 3,000,000 fry, and indicated that this is probably the best site on the coast for collecting the eggs of this species, which up to this time has received very little attention from the Commission.

SOME RESULTS OF FISH CULTURE.

During the year, 242 letters were addressed to applicants who had received fish in 1899, inquiring as to the results of the plants. Of the 129 replies received, 86 showed that waters had been successfully stocked, 20 indicated failure, and 23 gave indefinite information. Investigation of the cases where failure occurred indicated that the waters were unsuited to the fish applied for. It has therefore been found very desirable to obtain from applicants more detailed and accurate information than has heretofore been asked for in regard to the waters to be stocked, and new blanks have been prepared with this in view. When the description of the waters to be stocked indicates that the fish for which an applicant has expressed a preference is well suited to them, it is customary to furnish the kind desired, but the Commission reserves the right to determine this point and to prescribe the proper species.

From correspondents in various parts of the country who have volunteered information and from others who have been asked to report the outcome of attempts to stock waters in which they were interested, the following data, showing some recent results of fish culture and fish acclimatization, have been obtained:

TROUT IN COLORADO, SOUTH DAKOTA, AND MONTANA.

Brook trout, rainbow trout, Scotch lake trout, and steelhead trout are now firmly established in Colorado, none of them being indigenous. The brook trout affords better fishing than the native black-spotted trout, and more eggs of the brook trout can be collected in Colorado than in any other State, where hatcheries are located, to which the species is native. In the Black Hills of South Dakota and adjacent country, where there were no brook trout twenty years ago, all of the before-named trouts are now caught. Very favorable reports have also come from Montana in regard to these and other fishes introduced in the waters of that State.

STEELHEAD TROUT IN THE GREAT LAKES REGION.

The steelhead trout, introduced into the tributaries of Lake Superior, was in evidence in greater numbers last spring during the spawning season than ever before. The fish ascended the Lester River as far as the dam near Duluth station, passing over all the falls below this dam, and could be seen jumping at almost any time of day from about the 20th of April to the 30th of May. From 150 to 200 large steelheads were caught by fishermen (worms being used as bait) on Lester River between the railroad bridge and the Fish Commission dam, a distance of 300 to 400 yards, all of them being males but three or four, and weighing from $1\frac{1}{2}$ to $4\frac{1}{2}$ pounds. The females refused to take the hook during the spawning season. These fish are frequently caught in the nets of the commercial fishermen along the north shore.

Under date of June 26, 1903, L. E. Baldridge, of the Duluth hatchery, reported that one year ago a plant of steelheads was made in Baker Lake, near Spooner, Wis., and that in June a specimen was brought to the station from that lake which weighed half a pound and was 11 inches long.

A report from Traverse City, Mich., states that many fish locally called rainbow trout, but which were undoubtedly steelheads, have been caught in the streams below Hoxie's Pond, near Acme; mention was made of one specimen 30 inches in length and weighing fully 12 pounds.

LANDLOCKED SALMON AND TROUT IN CALIFORNIA.

Mr. Charles A. Vogelsang, chief deputy of the California fish commission, reports as follows: The consignment of 25,000 landlocked salmon furnished in 1899 arrived in rather poor condition, and the results were not as satisfactory as could be wished. About 17,000 of the fry were planted in Lake Tahoe, where occasional specimens are taken; 1,000 fry were placed in a lake in Placer County, near Cisco, in the Sierra Nevada Mountains, and two or three specimens have been taken this year, the largest weighing about 4 pounds. It was the impression of the superintendent who hatched the eggs that the loss was unusually heavy, and the surviving fry were not strong, but enough has been done to demonstrate that under favorable conditions these fish will flourish in our mountain lakes. Loch Leven and German brown trout, the eggs of which were furnished by the United States Fish Commission, have produced good results. They were planted principally in lakes, but some of the brown trout were placed in streams. A previous State board decided that they were destructive to other forms of trout life, and discontinued their further propagation. In Donner Lake, Loch Levens weighing 4 or 5 pounds are taken. Mackinaw trout (*Cristivomer namaycush*), hatched from eggs furnished by the United States Fish Commission, were planted in Lake Tahoe, and have done better than any other of the fishes introduced in those waters.

STRIPED BASS AND SHAD IN CALIFORNIA.

Regarding these fish Mr. Vogelsang writes: The history of our striped bass propagation is so well known that we will simply refer to it briefly by saying that 100 small fish planted in 1879, and 350 in 1882, in the Straits of Carquinez, have developed so that we are marketing in this city about 2,000,000 pounds annually. They are frequently found weighing from 35 to 40 pounds, and a number of specimens have been brought in that reached 50 pounds. These fish were not known to the waters of the Pacific until introduced through the agency of the United States Fish Commission. Shad have increased so enormously that the principal dealers restrict the catch, and they are sometimes sold for 25 cents per box of about 75 pounds.

RAINBOW TROUT IN NORTH CAROLINA.

The Toxaway Company, writing about the stocking of Fairfield Lake with rainbow trout in 1899, states that in 1902 and 1903 fish were taken from the lake weighing $4\frac{1}{2}$ and $4\frac{3}{4}$ pounds. The water seems especially well adapted to these fish; they grow rapidly and are excellent from every standpoint—gamy, full of life, and good table fish.

RAINBOW TROUT IN PENNSYLVANIA.

Mr. E. H. Ashcraft, of the Coudersport Rod and Gun Club, reports that rainbow trout are doing nicely in streams that were originally filled with speckled trout. In the spring of 1903 one was caught which was 22 inches long and weighed $5\frac{1}{2}$ pounds. In 1899 he stocked two ponds, one being the reservoir supplying Coudersport, and has been able to keep watch on the fish. They have grown well and in 1903 weighed 2 to $2\frac{1}{2}$ pounds, and have been multiplying so that there have been two runs of young fish from the reservoir into the main stream supplying it. The large fish will be transferred to a new pond that is being built.

BLACK BASS AND CRAPPIE IN NEW JERSEY, PENNSYLVANIA, AND MASSACHUSETTS.

A correspondent at Burlington writes: The black bass sent to me have done splendidly. Our state prohibits fishing in stocked waters for a period of three years, so you can see they have had a good chance. The first day after the three years expired there were over 100 fish caught, some weighing more than 5 pounds. The fishermen were greatly surprised to see that they had done so well.

An applicant for crappie for Lake Popanoming, Pennsylvania, states that the fish spawned and multiplied, and that recently as many as 90, each weighing 1 pound or thereabouts, were taken by a single rod during some of the best days of the season. The fish he received were divided into two lots, one part going to Cranberry Lake, New Jersey, where they have done equally well. From some others, placed in Lake Hoptacong, no reports have yet been received.

The Connecticut River between the Holyoke dam and Turners Falls was stocked with black bass in 1898, 1899, and 1900, each consignment consisting of 200 to 300 fish. The river at Holyoke is more than 1,000 feet wide, and the distance between the two points named is about 30 miles. Most of the illegal fishing in this stretch of the river has been stopped, and it is reported that there has been a decided increase in the number of black bass from that time.

SPOTTED CAT-FISH IN POTOMAC RIVER.

The Potomac River between Great Falls and Alexandria has been very successfully stocked with spotted cat-fish from the Mississippi River, and at present this species is one of the most desirable fishes caught by anglers. The largest specimens reported from the Potomac have weighed upward of 20 pounds. The average weight of those taken with hook and line is about $2\frac{1}{2}$ to 3 pounds, and many weigh 4 to 12 pounds. This is regarded as an excellent game species.

OPERATIONS OF THE STATIONS.

The stations and substations at which fish-cultural operations were conducted in 1903, with the persons in charge, were as follows, the permanent hatcheries being indicated thus * and the subsidiary stations being shown thereunder:

Name of station.	In charge.
*Green Lake, Me	E. E. Race, superintendent.
*Craig Brook, Me	Charles G. Atkins, superintendent.
Grand Lake Stream, Me	Do.
*Nashua, N. H	W. F. Hubbard, superintendent.
*St. Johnsbury, Vt	E. N. Carter, superintendent.
Swanton, Vt	Do.
*Gloucester, Mass	C. G. Corliss, superintendent.
*Woods Hole, Mass	E. F. Locke, superintendent.
*Cape Vincent, N. Y	Livingston Stone, superintendent.
Steamer Fish Hawk (Delaware River)	James A. Smith, commanding.
*Battery, Md	George H. H. Moore, superintendent.
*Bryans Point, Md	L. G. Harron, superintendent.
*Fish Lakes, D. C	C. K. Green, superintendent.
*Wytheville, Va	George A. Seagle, superintendent.
*White Sulphur Springs, W. Va	Robert K. Robinson, superintendent.
*Erwin, Tenn	Alexander Jones, superintendent.
*Cold Springs, Ga	J. J. Stranahan, superintendent.
*Edenton, N. C	S. G. Worth, superintendent.
Weldon, N. C	Do.
*Put in Bay, Ohio	S. W. Downing, superintendent.
*Northville, Mich	Frank N. Clark, superintendent.
Detroit, Mich	Do.
Sault Ste. Marie, Mich	Do.
Charlevoix, Mich	Do.
Alpena, Mich	Do.
*Quincy, Ill	S. P. Bartlett, superintendent.
*Manchester, Iowa	R. S. Johnson, superintendent.
Bellevue, Iowa	Do.
*Neosho, Mo	H. D. Dean, superintendent.
*San Marcos, Tex	J. L. Leary, superintendent.
*Leadville, Colo	E. A. Tulian, superintendent.
*Spearfish, S. D	D. C. Booth, superintendent.
*Bozeman, Mont	J. A. Henshall, superintendent.
*Baird, Cal	H. G. Lambson, superintendent.
Battle Creek, Cal	Do.
Mill Creek, Cal	Do.
*Clackamas, Oreg	J. N. Wisner, superintendent.
Little White Salmon, Oreg	Claudius Wallich.
Big White Salmon, Oreg	George H. Tolbert.
Eagle and Tanner creeks, Oreg	E. C. Greenman.
Rogue River, Wash	John W. Berrian.
*Baker Lake, Wash	Henry O'Malley, superintendent.
Birdsview, Wash	Do.

The output of the individual stations is shown in the following table; the figures in the notes are to be taken in addition to the regular figures in determining the operations of each hatchery:

Fish and eggs furnished for distribution by stations of the U. S. Commission of Fish and Fisheries during the fiscal year ending June 30, 1903.

Source of supply.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Green Lake, Me.[a]	Brook trout	355,000	880,000	115,137
	Landlocked salmon	125,000		258,806
Craig Brook, Me.[b]	Steelhead trout		5,582	353
	Scotch sea trout	2,500		199
	Lake trout		40,646	
	Grayling		17,114	12
	Atlantic salmon		1,632,273	304,016
	Landlocked salmon	55,000		61,709
Grand Lake Stream, Me	Landlocked salmon		196,132	58,835
Nashua, N. H	Brook trout	35,000	476,000	107,599
	Rainbow trout			5,640
	Lake trout		171,695	9,100
	Golden trout		16,825	4,200
	Grayling		30,000	
	Hybrid trout			1,720
	Landlocked salmon			17,800
St. Johnsbury, Vt.[c]	Brook trout	176,000	900,350	5,550
	Rainbow trout			2,574
	Steelhead trout		19,860	35,240
	Lake trout		178,000	
	Grayling			356
	Canadian red trout			535
	Landlocked salmon			14,473

[a] Transferred to Craig Brook Station 125,000 brook-trout fry, and to other stations of the U. S. Fish Commission 60,000 landlocked-salmon eggs.

[b] Transferred to other stations 50,000 landlocked-salmon eggs.

[c] Transferred to other stations 19,000 brook-trout eggs, and to Nashua Station 165,000 brook-trout fry and 130 Canadian red trout.

Fish and eggs furnished for distribution, etc.—Continued.

Source of supply.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Swanton, Vt. (substation)[a]	Pike perch	11,500,000	18,112,203	
	Yellow perch		21,467,500	
Gloucester, Mass	Cod		23,493,000	
	Flat-fish		161,040,000	
	Lobster		58,770,000	
Woods Hole, Mass	Cod		63,899,000	
	Flat-fish		84,385,000	
	Tautog		5,867,000	
	Scup		280,000	
	Mackerel		281,000	
	Lobster		9,861,000	
	Sea bass		920,000	
Cape Vincent, N.Y	Brook trout		377,000	
	Lake trout		6,443,170	
	White-fish		25,500,000	
	Pike perch		4,650,000	
	Landlocked salmon		4,400	
Steamer Fish Hawk	Shad	85,000	8,205,000	
Battery, Md.[b]	Shad	1,433,000	14,515,000	
	White perch	445,000	30,863,000	
Fish lakes, Washington, D.C	Black bass			134,642
	Crappie			6,597
Central Station, Washington, D.C.	Brook trout		17,531	
	Rainbow trout		4,384	
	Lake trout		60,881	
	Shad		5,001,544	
	Pike perch		2,500,000	
	Yellow perch	8,000,000		
	White-fish		257,000	
Bryan Point, Md.[c]	Shad	1,037,000	64,810,000	
Wytheville, Va.[d]	Brook trout			91,801
	Rainbow trout	32,000	162,850	164,926
	Black bass			39,530
	Rock bass			7,375
White Sulphur Springs, W.Va	Brook trout		200,000	
	Rainbow trout		69,000	
Erwin, Tenn.[e]	Brook trout			27,200
	Rainbow trout		141,000	81,547
	Black bass			1,075
Cold Springs, Ga.[f]	Black bass			91,545
	Strawberry bass			800
	Warmouth bass			1,400
	Sun-fish			17,900
	Cat-fish			61,825
Edenton, N.C	Shad		25,519,000	
Weldon, N.C	Striped bass		3,125,000	
Put-in Bay, Ohio[g]	White-fish	38,052,000	71,125,000	
	Lake trout		491,600	
	Lake herring		1,500,000	
	Pike perch	70,000,000	105,325,000	
Northville, Mich.[h]	Brook trout		971,000	
	Loch Leven trout		80,000	
	Steelhead trout		25,000	
	Lake trout	5,850,000	3,300,000	
	Landlocked salmon		3,000	
Detroit, Mich. (substation)[i]	Pike perch		2,000,000	
	White-fish	25,275,000	42,250,000	
Sault Ste. Marie, Mich. (substation).	Lake trout		4,500,000	
	White-fish		35,000,000	
Charlevoix, Mich. (substation).	Lake trout		4,800,000	
	White-fish		25,000,000	
Alpena, Mich. (substation)	Lake trout		2,385,000	
	White-fish		30,000,000	
Duluth, Minn.[j]	Rainbow trout		2,000	
	Steelhead trout		48,313	
	Brook trout		98,000	
	Lake trout	2,435,896	6,880,000	
	White-fish		17,000,000	
	Pike perch		3,900,000	

[a] Transferred to Central Station 12,787,500 yellow-perch eggs.
[b] Transferred to Central Station 460,000 white-perch eggs.
[c] Transferred to Central Station, Washington, D. C., 5,967,000 shad eggs.
[d] Transferred to Northville Station 16,000 yearling brook trout, and to other stations 106,000 rainbow-trout eggs.
[e] Transferred to White Sulphur Springs Station, W. Va., 520 brook-trout yearlings for breeders.
[f] Transferred to Erwin Station 200 cat-fish for breeders.
[g] Transferred to other stations 30,000,000 pike-perch eggs.
[h] Transferred to other stations 8,685,000 lake-trout eggs.
[i] Transferred to other stations 158,365,000 white-fish eggs.
[j] Transferred to other stations 9,386,320 lake-trout eggs.

Fish and eggs furnished for distribution, etc.—Continued.

Source of supply.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Quincy, Ill	Black bass			80,870
	Crappie			22,365
	Sun-fish			4,025
	Cat-fish			725
	Yellow perch			5,450
Manchester, Iowa[a]	Brook trout		255,000	7,995
	Rainbow trout	175,000	259,000	117,000
	Loch Leven trout		4,300	1,450
	Steelhead trout			42,500
	Lake trout		9,700	
	Quinnat salmon		7,000	2,700
	Landlocked salmon			600
	Rock bass			13,850
	Pike perch		2,600,000	
Bellevue, Iowa (substation)	Black bass			81,030
	Crappie			375,985
	Sun-fish			108,360
	Cat-fish			87,480
	Pike perch			3,915
	Pike			15
	Buffalo-fish			200,000
	Yellow perch			25,000
Neosho, Mo.[b]	Rainbow trout	10,000	14,500	42,[illegible]68
	Lake trout		1,125	
	Black bass			6,379
	Rock bass			28,700
	Strawberry bass			3,000
	Cat-fish			50,825
	Steelhead trout			2,900
	Quinnat salmon			2,500
San Marcos, Tex	Black bass			101,215
	Crappie			225
	Strawberry bass			50
	Rock bass			5,450
	Sun-fish			2,435
	Cat-fish			50
Leadville, Colo.[c]	Brook trout	350,000	1,546,500	299,500
	Black-spotted trout	20,000		1,653,000
	Lake trout		5,000	2,400
	Grayling		40,000	
	Rainbow trout		26,000	
	Steelhead trout			30,000
	Landlocked salmon			4,500
Spearfish, S. Dak.[d]	Brook trout	90,000	552,500	46,000
	Rainbow trout		44,000	37,000
	Loch Leven trout		146,500	
	Black-spotted trout			535,000
Bozeman, Mont.[e]	Rainbow trout			28,500
	Steelhead trout			17,500
	Brook trout			97,500
	Black-spotted trout		120,000	345,000
	Lake trout			11,000
	Grayling	445,000	887,000	
	White-fish		600,000	
Baird, Cal.[f]	Quinnat salmon	1,065,477	1,618,066	
Battle Creek, Cal. (substation).[g]	Quinnat salmon	5,684,300		
Mill Creek, Cal. (substation).[h]	Quinnat salmon	3,880,000		
Clackamas, Oreg	Brook trout		60,500	8,364
	Rainbow trout		7,500	
	Steelhead trout			62,033
	Lake trout		11,500	
	Quinnat salmon	3,006,400	3,663,760	250
	White-fish		274,040	
Little White Salmon, Wash. (substation).	Quinnat salmon		12,077,340	

[a] Transferred to other stations 315,000 rainbow-trout eggs.
[b] Transferred to other stations 279,800 rainbow-trout eggs.
[c] Transferred to other stations 400,000 brook-trout eggs and 10,000 rainbow-trout eggs.
[d] Transferred to other stations 100,000 brook-trout eggs and 10,000 Loch Leven trout eggs.
[e] Transferred to other stations 200,000 grayling eggs and 20,000 black-spotted trout eggs.
[f] There were also used for experimental purposes 5,000 quinnat-salmon eggs.
[g] There were also used for experimental purposes 21,000 quinnat-salmon eggs.
[h] Transferred to other stations from Mill Creek 520,000 quinnat-salmon eggs.

Fish and eggs furnished for distribution, etc.—Continued.

Source of supply.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Big White Salmon, Wash. (substation).[a]	Quinnat salmon		4,696,690	
Rogue River, Oreg. (substation).[b]	Quinnat salmon	1,878,000	1,790,100	
	Silver salmon	680,800		
	Black-spotted trout		80,900	
	Steelhead trout		262,700	
Baker Lake, Wash.[c]	Blueback salmon		3,731,789	
	Silver salmon		81,812	
	Steelhead trout	80,000	440,000	223,815

[a] Stations at Tanner and Eagle creeks were operated as auxiliaries of the Little and Big White Salmon stations.
[b] Transferred to Duluth Station 50,000 steelhead-trout eggs from Rogue River.
[c] Transferred to other stations 350,000 steelhead-trout eggs.

DETAILS OF DISTRIBUTION.

In the following table all plants of fish and allotments of eggs are shown by species and waters, the states being given in alphabetical order:

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Shad:			
State Fish Commission, Deep River, Conn		2,559,000	
Nanticoke River, Seaford, Del		2,500,000	
Indian River, Millsboro, Del		850,000	
Brandywine Creek, Wilmington, Del		3,050,000	
Smyrna Creek, Clayton, Del		150,000	
Leipsic Creek, Cheswold, Del		150,000	
St. Jones Creek, Dover, Del		400,000	
Murderkill Creek, Felton, Del		400,000	
Murderkill Creek, Ellendale, Del		150,000	
Mispillion Creek, Milford, Del		400,000	
Anacostia River, Bennings, D. C		701,649	
Potomac River, Aqueduct Bridge, D. C		804,930	
Savannah River, Augusta, Ga		1,162,800	
Ogeechee River, Millen, Ga		387,600	
Ocmulgee River, Macon, Ga		387,600	
Potomac River, off Bryan Point, Md		8,517,000	
Pamunkey Creek, Md		4,512,000	
Swan Creek, Md		3,406,000	
Broad Creek, Md		3,555,000	
Piscataway Creek, Md		6,718,000	
Point of Rocks, Md		504,465	
Gunpowder River, Gunpowder Station, Md		395,000	
Northeast River, Carpenter Point, Md		225,000	
Charlestown, Md		750,000	
Susquehanna River, Garrett Island, Md		750,000	
Bush River, Bush River Station, Md		890,000	
Patuxent River, Laurel, Md		400,500	
Patapsco River, Relay, Md		590,000	
Elk Creek, Elkton, Md		859,000	
Swan Creek, Swan Creek, Md		908,000	
Chesapeake Bay, off Battery Station, Md		850,000	
Eastern Flats, Md		200,000	
Susquehanna River, Port Deposit, Md		188,000	
State Fish Commission, Druid Hill Park, Md	1,028,000		
P. S. Freize, Baltimore, Md	105,000		
State Fish Commission, South Hanson, Mass		1,350,000	
South River, Old Bridge, N. J		450,000	
Delaware River, Howells Cove, N. J	85,000	5,056,000	
Lambertville, N. J		450,000	
Washingtons Crossing, N. J		862,000	
off Bennetts Fishery, N. J		487,000	
Salem Creek, Salem, N. J		450,000	
New York Aquarium, Battery Park, N. Y	1,337,000		
Trent River, Pollokswille, N. C		589,000	
Neuse River, Newbern, N. C		900,000	
Pamlico River, Washington, N. C		1,209,000	
Cape Fear River, Wilmington, N. C		935,000	
Fayetteville, N. C		500,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Shad—Continued.			
Pasquotank River, Elizabeth City, N. C		987,000	
Six Runs River, Clinton, N. C		600,000	
Chowan River, Willow Branch, N. C		1,543,000	
Reedy Point, N. C		802,000	
Roanoke River, Plymouth, N. C		715,000	
Weldon, N. C		600,000	
Perquimans River, Hertford, N. C		400,000	
Newport River, Morehead City, N. C		689,000	
Salmon Creek, Avoca, N. C		7,105,000	
Albemarle Sound, Hornblower Point, N. C		2,127,000	
Bachelor Bay, N. C		1,241,000	
Edenton Bay, Cherry Point, N. C		1,629,000	
Reedy Point, N. C		370,000	
Susquehanna River, Fites Eddy, Pa		450,000	
Delaware River, Yardley, Pa		450,000	
Black River, Georgetown, S. C		1,874,250	
Pedee River, Pedee, S. C		624,750	
Catawba River, Catawba River, S. C		387,600	
Broad River, Blacksburg, S. C		258,400	
San Jacinto River, Conroe, Tex		1,000,000	
Trinity River, Riverside, Tex		1,000,000	
Nottaway River, Courtland, Va		449,000	
Potomac River, off Hunting Creek, Va		6,337,000	
Pohick Creek, Va		9,180,000	
Occoquan Bay, Va		4,925,000	
Dove Creek, Va		5,950,000	
Blackwater River, Franklin, Va		474,000	
Nansemond River, Suffolk, Va		450,000	
Stony Creek, Stony Creek, Va		1,235,000	
Potomac River, near Hancock, W. Va		500,000	
Total	2,555,000	117,862,544	
Striped bass:			
Roanoke River, Weldon, N. C		3,125,000	
Quinnat salmon:			
Mammoth Spring, Mammoth Spring, Ark			100
McCloud River, Baird, Cal		1,087,495	
Pitt River, Pitt River Ferry, Cal		360,000	
Baird, Cal		130,571	
Salt Creek, Salt Creek Bridge, Cal		10,000	
R. D. Hume, San Francisco, Cal	1,378,000		
State Fish Commission, Sisson, Cal	7,455,477		
Baird, Cal	600,000		
Eel River, Cal	2,080,300		
Lake Okoboji, Spirit Lake, Iowa			2,700
Clear Lake, Clear Lake, Iowa		7,000	
Blue Lodge Springs, Bourbon, Mo			400
Lake Hahatonka, Lake Hahatonka, Mo			2,000
Oregon Fish Commission, Salem, Oreg	2,000,000		
Glide, Oreg	1,006,400		
Spring Branch, Clackamas, Oreg		159,350	
Rogue River Trail, Oreg	500,000	1,790,100	
Hood River, Hood River, Oreg		100,000	
Clackamas River, Clackamas, Oreg		3,504,410	250
Columbia River, Viento, Oreg		7,886,840	
Big White Salmon River, Underwood, Wash		316,000	
Columbia River, Underwood, Wash		1,470,000	
Collins, Wash		300,000	
Spring Branch, Underwood, Wash		2,810,690	
Little White Salmon River, Little White Salmon Station, Wash		3,890,500	
Tasmania Fish Commission, Hobart, Tasmania	494,000		
Total	15,514,177	23,852,956	5,450
Atlantic salmon:			
Aquarium, Zoological Park, D. C			100
Pleasant River, Brownville, Me		491,000	69,120
West Branch Mattawamkeag River, Oakfield, Me			44,248
East Branch Mattawamkeag River, Oakfield, Me			94,250
East Branch Penobscot River, Grindstone, Me			91,500
Hart Pond, East Orland, Me		2,613	4,296
Alamoosook Lake, Oakfield, Me		241,416	
Toddy Pond, Orland, Me		145,380	
Mattawamkeag Lake, Oakfield, Me		448,000	
Penobscot River, Grindstone, Me		254,000	
New York Aquarium, Battery Park, N. Y			100
Total		1,582,409	303,614

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Landlocked salmon:			
Twin Lakes, Twin Lakes, Colo			4,500
State Fish Commission, Windsor Locks, Conn	10,000		
Zoological Park Aquarium, Zoological Park, D. C			100
Fish Pond, Jackman, Me			1,000
Molasses Pond, Franklin, Me			1,000
Sebec Lake, Foxcroft, Me			2,000
Great Pond, Belgrade, Me			3,000
Long Pond, Ellsworth, Me			2,000
Blunt Pond, Ellsworth, Me			4,000
Tunk Pond, Tunk Pond, Me			12,500
Branch Mill Pond, Palermo, Me			1,000
Phillips Lake, Dedham, Me			6,310
Morrison Ponds, Dedham, Me			1,500
China Lake, East Vassalboro, Me			1,500
Swan Lake, Belfast, Me			2,000
Canaan Lake, Camden, Me			2,500
Upper Dobsis Lake, Winn, Me			1,000
Lily and Spectacle ponds, Shirley, Me			1,500
Long Pond, Bar Harbor, Me			1,000
Quantabacook Pond, Searsmont, Me			1,000
Moosehead Lake, Greenville, Me			7,000
Lawyer Pond, Greenville, Me			1,000
Clearwater Pond, Farmington, Me			4,000
Varnum Pond, Farmington, Me			2,000
Big Island Pond, Farmington, Me			2,000
Unity Pond, Unity, Me			4,000
Rangeley Lake, Rangeley, Me			3,000
Gull Pond, Rangeley, Me			2,000
Pemaquid Ponds, Damariscotta, Me			2,000
Jackson Pond, Bingham, Me			1,000
Alford Lake, Rockland, Me			2,000
Boyden Lake, Eastport, Me			1,000
Clearwater Lake, Allens Mills, Me			2,000
South Lake, Warren, Me			1,000
Lake St. George, Liberty, Me			3,000
Cobbosseecontee Lake, Winthrop, Me			13,000
Moose and Morrill ponds, Hartland, Me			1,500
Hobbs Pond, Hope, Me			1,250
Lovell Pond, Fryeburg, Me			2,000
Spring Lake, Stratton, Me			1,000
Mooselucmaguntic Lake, Oquossoc, Me			10,000
Sandy Pond, Freedom, Me			1,000
Lake Thompson, Oxford, Me			1,000
Spruce Lake, Cherryfield, Me			1,000
Pierce Pond, Madison, Me			2,000
Wilson Lake, Wilton, Me			1,200
Lake George, Skowhegan, Me			1,000
Otter Ponds, The Forks, Me			4,500
Lake Sebasticook, Newport, Me			1,000
Little Pond, Franklin, Me			1,000
Donnels Pond, Franklin, Me			3,500
Chase Pond, Bingham, Me			1,000
Howard Pond, Hanover, Me			1,000
Holeb Pond, Holeb, Me			1,500
Woods Pond, Blue Hill, Me			21,000
Lake Anasagunticook, Canton, Me			1,000
Sebago Lake, Sebago Lake, Me			29,300
Randall Pond, Brooks, Me			3,000
Passagasawaukee Lake, South Brooks, Me			2,000
Duck Lake, Winn, Me			1,000
Sweets Pond, New Vineyard, Me			1,000
Hancock Pond, North Anson, Me			1,000
Weld Pond, Berry Mills, Me			1,000
Mirror Lake, West Rockport, Me			1,000
Tributary of Sebago Lake, Mattacks Station, Me			2,000
Pillsbury Pond, Newport, Me			1,000
Bee Pond, Bethel, Me			1,000
Messalonskee Lake, Oakland, Me			1,505
Toddy Pond, East Orland, Me			19,250
Craig Pond, East Orland, Me			2,008
Patten Pond, Orland, Me			6,030
Green Lake, Otis, Me			40,500
Branch Pond, Dedham, Me			12,960
Portage Lake, Portage Lake, Me			12,500
Patten Pond, Ellsworth, Me			2,000
Sysladobsis Lake, Grand Lake Stream, Me		8,005	8,005
Grand Lake Stream, Washington County, Me		188,117	50,830
Long Lake, Harrison, Me			7,000
Long Pond, Great Pond, Me			1,996
Toddy Pond, Surry, Me			5,246
Williams Pond, Bucksport, Me			4,160
State Fish Commission, Greenville Junction, Me	30,000		
Parmachenee Club, Camp Caribou, Me	20,000		

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Landlocked salmon—Continued.			
Megantic Fishing and Game Club, Portland, Me	20,000		
Silver Lake, Wilmington, Mass			700
City Reservoir, Worcester, Mass			700
State Fish Commission, Wilkinsonville, Mass	20,000		
Tehanto Club, Wenaumet, Mass	5,000		
Big Blue Lake, Muskegon, Mich			660
State Fish Commission, Paris, Mich	20,000		
Pleasant Pond, New London, N. H			1,400
Lake Sunapee, New London, N. H			7,598
Penacook Lake, Concord, N. H			1,000
Merry Meeting Pond, New Burnham, N. H			1,000
Lake Winnepecket, Warner, N. H			1,000
Stinson Lake, Rumney, N. H			1,000
Spofford Lake, Chesterfield, N. H			1,000
Newfoundland Lake, Bristol, N. H			1,400
Lake Tarleton, Pike Station, N. H			2,000
Connecticut Lake, Polebrook, N. H			1,000
Dan Hole Pond, Moultonville, N. H			1,600
State Fish Commission, Plymouth, N. H	10,000		
Belknap County Club, Laconia, N. H	10,000		
Lake Mahopac, Lake Mahopac, N. Y			500
New York Aquarium, Battery Park, N. Y			100
Beaver River, Beaver, N. Y		1,300	
Tuxedo Club, Tuxedo Park, N. Y	5,000		
C. H. Wilson, Glens Falls, N. Y	5,000		
Toxaway Club, Brevard, N. C	5,000		
Sandy Lake, Ravenna, Ohio		3,000	
State Fish Commission, Salt Lake City, Utah	10,000		
Little Averill Pond, Averill, Vt			2,000
Long Pond, Westmore, Vt			1,500
Willoughby Lake, Westmore, Vt			2,500
West Burke, Vt			1,000
Long Pond, West Burke, Vt			1,000
Caspian Lake, Greensboro, Vt			8,373
Lake Dunmore, Salisbury, Vt			1,800
J. B. Feilding, Upper Downing, North Wales	10,000		
Total	180,000	203,422	115,321
Silver salmon:			
Rogue River, Trail, Oreg	680,800		
Skagit River, Baker Lake, Wash		81,812	
Blueback salmon:			
Baker Lake, Baker Lake, Wash		3,731,789	
Steelhead trout:			
St. Vrain River, Lyons, Colo			14,000
Platte River, between Grant and Platte Canyon, Colo			15,000
Lake Coeur d'Alene, Coeur d'Alene, Idaho			8,000
Clear Lake, Clear Lake, Iowa			20,000
Shell Rock River, Mason City, Iowa			20,000
Spirit Lake, Spirit Lake, Iowa			2,500
Dead River, Orland, Me		5,582	
Alamoosook Lake, East Orland, Me			353
Big Sturgeon River, Indian River, Mich		24,800	
Lester River, Duluth, Minn		23,313	
Bennetts Mill Pond, Lebanon, Mo			2,560
Blue Lodge Springs, Bourbon, Mo			400
Fish Pond, White Hall, Mont			1,500
Axolot Lake, Alder, Mont			2,000
Tom Creek, Monida, Mont			2,500
Penacook Lake, Concord, N. H			5,240
Lake Hiawatha, Sykeston, N. Dak		9,000	
Rogue River, Trail, Oreg		100,000	
Rogue River, Oreg		162,700	
Clatskanie River, Oregon City, Oreg			37,053
Utah Fish Commission, Salt Lake City, Utah	20,000		
Willoughby Lake, Westmore, Vt			15,000
Newark Pond, Newark, Vt			10,000
Crystal Lake, Barton, Vt		9,860	5,000
Dioms Brook, Swanton, Vt		10,000	
Green Lake, Seattle, Wash			28,200
Phinney Creek, Birdsview, Wash		80,000	70,000
Quartz Creek, Birdsview, Wash			33,815
Grandy Creek, Birdsview, Wash		360,000	120,000
Christie Lake, Spooner, Wis		15,000	
H. C. Pierce, Lake Nebagimaine, Wis	20,000		
J. C. Cable, Bosler, Wyo	20,000		
J. B. Feilding, Upper Downing, North Wales	20,000		
Total	80,000	800,255	413,041

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Loch Leven trout:			
Sheffield Creek, South Bend, Ind			400
Spring Branch, Forestville, Iowa		4,360	
Norris Creek, Spring Lake, Mich			500
Boardman Lake, Traverse City, Mich			500
Big Sturgeon River, Indian River, Mich		25,000	
Mill Creek, Mill Creek, Mich		25,000	
Hayes Creek, Mill Creek, Mich		10,000	
Upper Bear Creek, Mill Creek, Mich		10,000	
Egypt Creek, Mill Creek, Mich		10,000	
Rapid Creek, Rapid City, S. Dak		15,000	
Lime Creek, Rapid City, S. Dak		7,500	
Sickler Pond, Rapid City, S. Dak		7,500	
Fish Pond, Sturgis, S. Dak		10,000	
Watercress Creek, Spearfish, S. Dak		5,000	
Franklin and Watercress creeks, near Spearfish, S. Dak		6,500	
Crow Creek, near Spearfish, S. Dak		5,000	
Spearfish Creek, Spearfish, S. Dak		10,000	
Trout Pond, Spearfish, S. Dak		8,000	
Little Elk Creek, Piedmont, S. Dak		5,000	
Little Rapid Creek, Rochford, S. Dak		5,000	
Squaw Creek, Maurice, S. Dak		5,000	
Elk Creek, Roubaix, S. Dak		25,000	
Little Spearfish Creek, Spearfish Falls, S. Dak		10,000	
East Fork of Spearfish Creek, Engelwood, S. Dak		5,000	
Tributary of Firehole River, Yellowstone Park, Wyo		9,500	
Total		223,360	1,400
Rainbow trout:			
Blackwater Creek, Jasper, Ala			1,000
Desoto River, Valley Head, Ala			1,500
Curtis Mill Pond, Haleysville, Ala			600
Spring Lake, Springville, Ala			300
Walnut Creek Pond, Prescott, Ariz			300
West Beaver Creek, Jerome, Ariz			200
Oak Creek, Jerome, Ariz			200
Clear Creek, Jerome, Ariz			200
Fish Pond, Prescott, Ariz			300
Silver Lake, Hiawasse, Ark			500
Spring Lake, Rogers, Ark			1,000
Clear Lake, England Station, Ark			500
Mammoth Spring, Mammoth Spring, Ark			5,000
Fish Lake, Morrillton, Ark			300
Davidson's Trout Pond, Fayetteville, Ark		2,000	
Clear Creek, Fayetteville, Ark		1,000	
Mountain Fork Creek, Hatfield, Ark		8,000	
Monte Ne Lake, Rogers, Ark		1,000	
Cimarron River, Cimarron, Colo			400
Shadeland Lake, Eastonville, Colo			400
Fish Pond, Montrose, Colo			300
Saguache Creek, Villa Grove, Colo			300
Trout Lake, Las Animas, Colo			500
Ridgway Ponds, Salida, Colo		26,000	
Connecticut Fish Commission, Windsor Locks, Conn	20,000		
Pemberton Branch, Ellendale, Del			800
Trout Pond, Zoological Park, D. C			112
McCleskey Lake, Gainesville, Ga			800
Trout Pond, Turnersville, Ga			500
Bridge Creek, Turnersville, Ga			800
Devils Den Creek, Turnersville, Ga			500
Moore Creek, Turnersville, Ga			500
Wheeler Creek, Turnersville, Ga			500
Spring Branch, Turnersville, Ga			500
Davidson Creek, Turnersville, Ga			500
Flat Creek, Turnersville, Ga			500
Glade Creek, Turnersville, Ga			500
Small stream, Turnersville, Ga			500
Branch of Shoal Creek, Clarksville, Ga			1,500
Shoal Creek, Clarksville, Ga			1,500
Fish Pond, Ellijay, Ga			100
Fish Pond, Dalton, Ga			500
Fish Pond, Tate, Ga			1,000
Portneuf River, Pocatello, Idaho			2,500
Spring Lake, Joliet, Ill			1,000
Fish Pond, Gilmore, Ill			500
Honey Creek, Ardmore, Ind. T			400
Haskell Spring, Fort Dodge, Iowa			1,000
Bloody Run, McGregor, Iowa			200
Volga River, Fayette, Iowa		10,000	10,000
Upper Iowa River, Decorah, Iowa		40,000	10,000
Turkey River, Cresco, Iowa			10,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Red Cedar River, Charles City, Iowa			10,000
Shell Rock River, Nora Springs, Iowa			10,000
Wapsipinicon River, Ionia, Iowa			10,000
Des Moines River, Estherville, Iowa			9,500
Little Sioux River, Spencer, Iowa			9,500
Bear Creek, Lansing, Iowa			2,000
Village Creek, Lansing, Iowa			3,000
Maquoketa River, Forestville, Iowa		40,000	13,000
Honey Creek, Manchester, Iowa		24,000	4,000
Bear Creek, Edgewood, Iowa		20,000	
Wapsipinicon River, McIntire, Iowa		29,950	
Little Cedar River, Little Cedar, Iowa		29,960	
Shell Rock River, Mason City, Iowa		30,000	
Des Moines River, Algona, Iowa		30,000	
Spring Branch, Manchester, Iowa		5,000	
Duck Creek, Manhattan, Kans			100
Chikaska River, Dodge City, Kans			500
Birch Creek, Wellington, Kans			400
Fish Pond, Langdon, Kans			400
Fountain Blue Creek, Elizabethtown, Ky			500
Turkey Run, Rocky Ridge, Md			800
Church Creek, Glencoe, Md			1,200
Long Branch, Forest Hill, Md			500
Lake Royer, Buena Vista Springs, Md			600
Bring Brook, Germantown, Md			500
Muddy Creek and Pond, Oakland, Md			1,000
Browning Dam, Oakland, Md			5,000
White Oak Run, Oakland, Md			1,000
Silver Spring, Silver Spring, Md			800
Mine Branch, Minefield, Md			800
Long Branch, Watervale, Md			500
Big Gunpowder River, Parkton, Md			1,100
Stewart Patton, Baltimore, Md	6,000		
R. C. Hart, Baltimore, Md	1,000		
Maryland Fish Commission, Baltimore, Md	50,000		
Coleton Brook, Conway, Mass			2,000
Mashpee Great Lake, Mashpee, Mass			600
Clear Creek, Nickerson, Minn		2,000	
Spring Lake, Verona, Mo			500
Little Crane Creek, Aurora, Mo			1,500
Trout Ponds, Noel, Mo			1,000
Humes Lake, Versailles, Mo			500
Big River, Annapolis, Mo			2,000
Bear Creek, Annapolis, Mo			2,000
Tributary of Big River, Irondale, Mo			2,000
St. Francis River, Loughboro, Mo			2,000
Current River, Domphan, Mo			1,375
Spring Creek, Marionville, Mo			1,000
Terral Springs, Billings, Mo			500
Spring Brook, Aurora, Mo			500
Spring Lake, Ritchey, Mo			500
Trout Ponds, Bethpage, Mo			500
Spring Pond, Cuba, Mo			500
Crooked Creek, Lutesville, Mo			500
Branch of Current River, Naylor, Mo			625
Blue Lodge Springs, Bourbon, Mo			1,000
Brazil Creek, Bourbon, Mo			2,000
Spring Pond, Nevada, Mo			200
Elm Lake, Moundville, Mo			300
McMahon Spring, near Neosho, Mo			1,630
Hickory Creek, near Neosho, Mo			238
Jenkins Creek, Aurora, Mo		1,000	
Black River, Williamsville, Mo		1,425	
A. Lauth, Fanning, Mo	10,000		
South Fork Reservoir, Feely, Mont			2,000
Barker Trout Pond, Anaconda, Mont			2,000
Spring Pond, Whitehall, Mont			1,500
Blacktail Deer Creek, Dillon, Mont			3,000
South Pondera Creek, Pondera, Mont			2,400
Wearley Lake, Chester, Mont			2,500
Middle Creek, Bozeman, Mont			5,000
Twin Lakes, Silver Bow Junction, Mont			3,000
Laws Lake, Kalispell, Mont			2,500
Spring Brook Lake, Omaha, Nebr			1,000
Nebraska Fish Commission, South Bend, Nebr	50,000		
Spectacle Pond, Canaan, N. H			640
Trout ponds and stream, Sunapee Lake, N. H			2,994
Decker Brook, Silver Lake, N. J			800
Fish Pond, Summit, N. J			400
Fish ponds, Rincon, N. Mex			800
Alamo Lake, Alamo Gordo, N. Mex			1,100

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
North Spring River, Roswell, N. Mex			800
Artificial Lake, Roswell, N. Mex			400
Gollinas River, Las Vegas, N. Mex			1,000
Bonita River, Capitan, N. Mex			400
Fish ponds, Engle, N. Mex			600
Indian Lake, Peekskill, N. Y			500
Fish Pond, Ellenville, N. Y			470
New York Aquarium, Battery Park, N.Y	14,000		
Shawnee Hall River, Elkpark, N. C			1,725
Elk River, Elkpark, N. C		15,000	2,275
Cherry Cona Creek, Waynesville, N. C			435
Indian and Mill creeks, Toxaway, N. C			700
Armstrong Creek, Marion, N. C			696
Clear Creek, Marion, N. C			696
Big Buck Creek, Marion, N. C			435
Mackeys Creek, Marion, N. C			435
Johnson Creek, Marion, N. C			435
Little Buck Creek, Marion, N. C			435
Buck Creek, Marion, N. C			435
Sams Creek, Marion, N. C			696
Watauga River, St. Jude, N. C			500
Trout Lake, Lenoir, N. C			435
Trout Pond, Morrisville, N. C			300
Clear Creek, Davidson River, N. C			500
Spring stream, Sanford, N. C			150
Kings Pond, Fayetteville, N. C			250
McKennon Pond, Fayetteville, N. C			500
Hyborta Creek, Fayetteville, N. C			125
Holly Oaks reservoir, Fayetteville, N. C			125
Canoe Creek, Morganton, N. C			435
Fork of Catawba River, Morganton, N. C			435
Irish Creek, Morganton, N. C			435
Fox Camp Creek, Morganton, N. C			435
Upper Johns River, Morganton, N. C			435
Hunter Creek, Huntsdale, N. C			1,200
Cane River, Green Mountain, N. C			1,000
Prices Creek, Cane River, N. C			500
Arranman Lake, Manchester, N. C			500
Spring Pond, Smithfield, N. C			500
Trout Run, Marion, N. C			500
Pond on hospital grounds, Raleigh, N. C			200
Tar River, Mill Pond, Louisburg, N. C			375
Sandy Creek, Louisburg, N. C			125
Trout Pond, Southern Pines, N. C			950
Big Creek, Haywood County, N. C			2,000
Niesson Park Pond, Winston-Salem, N. C			500
Fish Pond, Guthrie, Okla			500
Fish Pond, Woodward, Okla			1,200
Toms Creek, Fairfield, Pa			1,000
Middle Creek, Fairfield, Pa			1,000
Marsh Creek, McKnightstown, Pa			600
Little Marsh Creek, Orrtanna, Pa			600
Rogue Harbor Brook, Westover, Pa			500
Kitchen Creek, Wilkesbarre, Pa			800
Pine Creek, Wilkesbarre, Pa			800
Huntingdon Creek, Wilkesbarre, Pa			800
Letort Spring, Carlisle, Pa			1,000
Bony Brook, Carlisle, Pa			200
Mountain streams, Foxburg, Pa			800
Red Run, Waynesboro, Pa			500
Dutchman Run, Laporte, Pa			500
Pole Bridge Run, Laporte, Pa			500
Big Run, Sonestown, Pa			500
Elk River, Nordmont, Pa			500
Bear Creek and Tenmile Run, Wilkesbarre, Pa			800
Mill Creek, Wilkesbarre, Pa			500
Shades Creek, Wilkesbarre, Pa			500
Ranshes Creek, Hamburg, Pa			800
Bachman Creek, Lebanon, Pa			600
Hammer Creek, Lebanon, Pa			1,200
Fink Creek, Lebanon, Pa			800
Blue Mountain Stream, Hamburg, Pa			500
Loyalhannah Creek, Ligonier, Pa			800
Hunter Run, Nordmont, Pa			800
Bear Run, Bear Run, Pa			2,500
Big Roaring Creek, Catawissa, Pa			500
Spring Run, Mercersburg, Pa			800
Big Creek, Frackville, Pa			400
Rattle Run, Frackville, Pa			400
Trout Pond, Shadesgap, Pa			500
Tumbling Run, Pottsville, Pa			500

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Tributary of Twelvemile Creek, Lexington, S. C.			800
Matthews Creek, Greenville, S. C.			1,000
Little Rapid Creek, Dumont, S. Dak.			15,000
Deer Creek and Ponds, Pactola, S. Dak.			1,500
Private Pond, Spearfish, S. Dak.			1,500
Rapid Creek, Rapid City, S. Dak.			2,500
Beaver Creek, Buffalo Gap, S. Dak.		10,000	5,000
Iron Creek, Hill City, S. Dak.			2,000
Castle Creek, Rochford, S. Dak.			2,000
Little Rapid Creek, Nahant, S. Dak.			2,000
Cascade Creek, Cascade, S. Dak.		10,000	
Franklin and Watercress creeks, near Spearfish, S. Dak.		9,000	
Spearfish Creek, Spearfish, S. Dak.		7,500	
South Indian Creek, Flagpond, Tenn.			1,300
Trout ponds, Flagpond, Tenn.			3,400
Rice Creek, Flagpond, Tenn.			1,200
Stamp Fork Creek, Flagpond, Tenn.			1,200
Fish Ponds, Kittyton, Tenn.			1,200
Tributary Duck River, Manchester, Tenn.			500
Flint River, Fayetteville, Tenn.			1,500
Fish Pond, Kenton, Tenn.			500
Baker and Lost creeks, Reliance, Tenn.			250
Trout Pond, Tazewell, Tenn.			300
Carrs Lake, Tazewell, Tenn.			500
Blue Hole Lake, Tazewell, Tenn.			300
Stone River, Murfreesboro, Tenn.			500
Talors Creek, Louisville, Tenn.			500
Mountain Stream, Rogersville, Tenn.			1,000
Fish Pond, Butler, Tenn.			300
King Creek, Rockwood, Tenn.			500
Patterson Creek, Rutledge, Tenn.			500
Richland Creek, Rutledge, Tenn.			500
Watervile Pond, Cleveland, Tenn.			300
Paint and Caney creeks, Greenville, Tenn.			1,000
Fish Pond, Morristown, Tenn.			435
Two Springs Lake, Newport, Tenn.			435
Spring Branch fishery, Tenn.			3,172
Fish Pond, Mason, Tenn.			800
Thomas and Red Fork creeks, Limestone Cove, Tenn.			1,200
Laurel and Shell creeks, Shellcreek, Tenn.			1,200
Sinking and Cedar creeks, Bristol, Tenn.			4,300
Field Creek, Bristol, Tenn.			1,300
Goose Creek, Bristol, Tenn.			2,400
Fish Pond, Petersburg, Tenn.			500
Caney Fork River, Caney Fork, Tenn.			3,100
North Forks of Roans Creek, Mountain City, Tenn.			500
Trout Pond, Waverly, Tenn.			300
Barber Fish Pond, Gallatin, Tenn.			300
Piney River, Nunnelly, Tenn.			1,000
Trout Pond, Medina, Tenn.			1,000
Hiawassee River, Appalachia, Tenn.			550
Coal Creek, Buckeye, Tenn.			500
Dicks Creek, Unicoi County, Tenn.			2,000
Rock Creek, Unicoi County, Tenn.			2,000
Martins Creek, Unicoi County, Tenn.			2,000
Indian Creek, Erwin, Tenn.			2,000
Thomas Creek, Unicoi, Tenn.		15,000	
Paint and Horse creeks, Greenville, Tenn.		6,000	
Mill Creek, Mountain City, Tenn.		9,900	
Middle Fork of Roan Creek, Mountain City, Tenn.		20,000	
North Fork of Roan Creek, Shounds, Tenn.		19,450	
South Fork of Spring Roan Creek, Shounds, Tenn.		9,900	
Mountain Spring Lake, Cleveland, Tenn.		9,500	
Ball and Sycamore creeks, Lone Mountain, Tenn.		11,000	
Cove Creek, Buckeye, Tenn.		9,000	
Tributary of Doe River, Elizabethton, Tenn.		10,000	
Fish Pond, Comanche, Tex.			500
W. M. Tillman, Salt Lake City, Utah	25,000		
Beaver Pond, Proctor, Vt.			2,557
Paddy Creek, Capon Roads, Va.			800
Trout brook, Glasgow, Va.			600
Spring Pond, White Post, Va.			400
Trout Pond, Hanover, Va.			300
Little Fort Run, Woodstock, Va.			800
Trout Pond, Wise, Va.			600
Trout Pond, Emporia, Va.			300
Cedar Creek, Natural Bridge, Va.		6,300	500
Trout Pond, near Richmond, Va.			300
Headwaters of Rappahannock River, Flint Hill, Va.			800
Darks Creek, Winchester, Va.			500
Spears Pond, Midlothian, Va.			300

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Difficult Creek, Bedford City, Va			500
Tumbling Creek, Saltville, Va			6,650
Leatherwood Pond, Axton, Va			125
Fork of Clinch River, Tazewell, Va			1,800
Headwaters of Clinch River, Tazewell, Va			700
Clear Fork of Clinch River, Tazewell, Va			19,000
Fish Pond, Proffit, Va			300
Mill Creek, Grant, Va			3,000
Fox Creek, Grant, Va			3,500
Dry River, Harrisonburg, Va		3,600	800
Fish Lake, Harrisonburg, Va			1,200
Fish Pond, Snake Creek, Va			1,500
Crab Creek, Vickers, Va			1,000
Shenandoah Pond, Lofton, Va			600
Willow Grove Pond, Roanoke, Va			500
Clinch River, Richlands, Va			11,200
Powells River, Appalachia, Va			1,700
Sinking Creek, Eggleston, Va			2,000
Mountain Lake, Eggleston, Va			18,000
Tributary of Holston River, Marion, Va			3,500
Little River, East Radford, Va			3,000
Tinkers Creek, Hollins, Va			2,400
Tributary of Smith River, Vesuvius, Va			1,200
Stuarts Draft, Va			2,000
Baker Spring Pond, Waynesboro, Va			2,600
Tub River, Shenandoah, Va			1,200
Water Branch, Ingham, Va			1,200
Hawkbill Creek, Luray, Va			3,000
Mountain Brook, Luray, Va			200
Trout Run, Boyds, Va			5,000
Woods Pond, Richmond, Va			150
Edgemere Lake, Richmond, Va			150
Snake Den Creek, Hunters, Va			500
Leatherwood Creek, Burnt Chimneys, Va			375
Tate Run, Wytheville, Va			158
Stone Run, Newcastle, Va		10,000	
Long Marsh Run, Gaylord, Va		15,000	
Guest River, Norton, Va			800
Occopink Creek, Fairfax, Va		4,284	
Trout Lake, Cedar Springs, Va		10,000	
Scotts Spring, Cedar Springs, Va		10,000	
Tinker Creek, Troutville, Va		5,000	
Irish Creek, Cornwall, Va		5,000	
South River, Midvale, Va		5,000	
Baker Spring, Waynesboro, Va		5,000	
Park Lake, Waynesboro, Va		5,000	
Spring Pond, Waynesboro, Va		5,000	
South Fork Shenandoah River, Grove Hill, Va		8,100	
Thornton River, Luray, Va		6,000	
Pass Run, Luray, Va		4,500	
Smith River, Vassett, Va		3,250	
Rug Creek, Martinsville, Va		5,200	
Trout Pond, Martinsville, Va		2,600	
Leatherwood Creek, Dyer Station, Va		1,300	
Furnall Creek, Rocky Mount, Va		6,000	
Big Fish Branch, Rocky Mount, Va		6,000	
Elliots Run, Lithia, Va		2,100	
Mountain Branch, Buenavista, Va		5,600	
Trout Pond, Buchanan, Va		1,200	
Two-mile Run, Island Fork, Va		3,600	
Porters Run, Millwood, Va		5,000	
Carter Hall Spring, Millwood, Va		5,000	
Atkins Mill Pond, Atkins, Va		500	
Laurel Creek and South Fork Holston River, Damascus, Va		5,000	
Long Branch, Ferrum, Va		1,000	
Thorp Creek, Ferrum, Va		1,000	
Otter Creek, Ferrum, Va		2,000	
Back Creek, Roanoke, Va		2,000	
Happy Creek, Front Royal, Va		2,000	
Spring Creek, Whitepost, Va		3,000	
E. S. Tucker, Norfolk, Va	1,000		
Owens Lake, Milan, Wash			1,900
Skikomish River, Madison, Wash		7,499	
Barnes Pond, Marlowe, W. Va			1,000
Snowy Creek, Terra Alta, W. Va			800
Spring Lake, Bluefield, W. Va			1,400
Trout Run, Romney, W. Va			2,600
Fish Pond, Welch, W. Va			700
Second Creek, Fort Spring, W. Va		14,500	
Turkey Creek, Fort Spring, W. Va		14,500	
Wolf Creek, Alderson, W. Va		20,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Meadow Creek, Shyrock, W. Va		10,000	
Dry Fork Creek, Iaeger, W. Va		6,000	
Middle Inlet, Athelstane, Wis			400
Otter Creek, Augusta, Wis			200
Bear Grass Creek, Augusta, Wis			200
Trout Brook, Augusta, Wis			800
Rock Creek, Mondovi, Wis			200
Harvey Creek, Mondovi, Wis			200
Hunter Creek, Mondovi, Wis			200
Bennett Valley Creek, Mondovi, Wis			200
Scott Creek, Fairchild, Wis			200
South Beet River, Osseo, Wis			200
Little Flora Creek, Tomah, Wis			200
Big Flora Creek, Tomah, Wis			200
Ford Creek, Tomah, Wis			200
Deer Creek, Tomah, Wis			200
Fish Pond, Racine, Wis			200
Valley Creek, Strum, Wis			200
Otter Creek, Eau Claire, Wis			600
Lowe Creek, Eau Claire, Wis			600
Beatty Creek, Hixton, Wis			200
South Branch Creek, Hixton, Wis			200
Lowe Creek, Hixton, Wis			200
Pine Creek, Hixton, Wis			200
Sherwood Creek, Hixton, Wis			200
Sly Creek, Hixton, Wis			200
Mormon Creek, La Crosse, Wis			400
Fall Creek, Fall Creek, Wis			200
Beaver Creek, Fall Creek, Wis			200
Squaw Creek, Sparta, Wis			200
Walrath Creek, Sparta, Wis			200
Bailey Creek, Sparta, Wis			200
Big Creek, Sparta, Wis			200
Stockwell Creek, Merrillan, Wis			200
Wright Creek, Merrillan, Wis			200
Van Hersey Creek, Merrillan, Wis			200
Cisna Creek, Merrillan, Wis			200
Coon Creek, La Crosse, Wis			200
Tan Creek, Tomah, Wis			200
Zertz Creek, Black River Falls, Wis			200
Allen Creek, Black River Falls, Wis			200
Squaw Creek, Black River Falls, Wis			200
Trout Streams, Sheridan, Wyo			2,500
Arnica Creek, Yellowstone Park, Wyo			3,000
Dome Lake, Sheridan, Wyo		7,500	1,000
Wyoming Fish Commission, Sheridan, Wyo	30,000		
Thomas E. Moore, Weimar, Germany	10,000		
Total	217,000	726,758	476,999
Black-spotted trout:			
First Chicago Lake, Idaho Springs, Colo			15,000
Second Chicago Lake, Idaho Springs, Colo			15,000
Lake San Cristoval, Lake City, Colo			75,000
Musgrove Lake, Union Gulch, Colo			10,000
South Arkansas River, Salida, Colo			25,000
Lost Lake, Idaho Springs, Colo			14,000
Chinns Lake, Idaho Springs, Colo			15,000
Miller Lake, Idaho Springs, Colo			15,000
St. Marys Lake, Idaho Springs, Colo			15,000
Eagle River and Gore Creek, Minturn, Colo			35,000
Alamosa River, Montevista, Colo			40,000
Escalanta Creek, Delta, Colo			20,000
Lake and Tennessee Forks of Arkansas River, Leadville, Colo			50,000
Lime Creek, Thomasville, Colo			20,000
Fryingpan River, Thomasville, Colo			20,000
Coal Creek, Telluride, Colo			15,000
Trail Creek in Laramie County, Colo			25,000
Trout Lake, Ophir, Colo			15,000
St. Vrains River, Lyons, Colo			75,000
Fryingpan River, Basalt, Colo			25,000
Nash, Colo			25,000
North Fork Fryingpan River, Norrie, Colo			25,000
Fryingpan River between Nast and Thomasville, Colo			75,000
Platte River between Grant and Platte Canyon, Colo			75,000
North Fork of San Juan River, Pagosa Springs, Colo			20,000
Eagle River and tributaries, Red Cliff, Colo			25,000
Grand Mesa Lakes, Grand Mesa, Colo			500,000
Forest Lake, Denver, Colo			50,000
Grizzly Creek, Glenwood Springs, Colo			50,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Black-spotted trout—Continued.			
Conejos and Pinnos River, Alamosa, Colo			35,000
Dallas Creek, Ridgway, Colo			30,000
Beaver Creek, Ridgway, Colo			10,000
Cool Creek, Ridgway, Colo			5,000
West Dolores Creek, Ridgway, Colo			5,000
Marshall and Tomiche creeks, Shirley and Chester, Colo			15,000
Grand River, Hot Sulphur Springs, Colo			9,900
Nailor Lake, Georgetown, Colo			5,000
East and Middle Beaver creeks, Clyde, Colo			25,000
Poncho Creek and Tomiche River, Mears Junction, Colo			25,000
Eagle River, Berry Station, Colo			20,000
Gypsum Creek, Gypsum, Colo			20,000
Upper Evergreen Lake, Evergreen Lake, Colo			8,000
Crystal River, Redstone, Colo			50,000
Fish Pond, Denver, Colo			5,000
Spring Pond, Idaho Falls, Idaho			1,500
Anderson Pond, Market Lake, Idaho			1,500
Emigrant Creek, Market Lake, Idaho			1,000
Bear Creek, Kendrick, Idaho			2,000
Fish Lake and Ponds, Orfino, Idaho			1,000
Snake River, Idaho Falls, Idaho			2,000
Cedar Mountain Creek, Athol, Idaho			5,000
Big Lost River, Mackay, Idaho			2,000
Pontneuf Creek, Pebble, Idaho			7,000
Lake Cœur d'Alene, Cœur d'Alene, Idaho			3,000
Trout Ponds, Henry Lake, Idaho		100,000	
Horn Creek, Norris, Mont		10,000	
Mystic Lake, Emigrant, Mont			3,000
Prickly Pear Creek Lake, Prickly Pear Junction, Mont			5,000
Belt Creek, Monarch, Mont			2,000
Browns Creek, Cascade, Mont			4,000
Harris Creek, Cascade, Mont			2,000
Sheep Creek, Cascade, Mont			2,000
Trout Pond, Scribner, Mont			5,000
Trout Pond, Lewiston, Mont			3,000
Sixteenmile Creek, Baker Station, Mont			8,000
Sweet Grass Creek, Big Timber, Mont			4,000
Trout Pond, Warm Spring, Mont			3,000
Rattlesnake Creek, Dillon, Mont			3,500
Cornet Creek, Dillon, Mont			3,000
Grasshopper Creek, Dillon, Mont			2,000
Clark Lake, Dillon, Mont			1,500
Fish Pond, Bonner, Mont			1,000
Ashley Creek and Lake, Kalispell, Mont			4,000
Gregg Creek, Kalispell, Mont			1,500
Lake Lavelle, Kalispell, Mont			5,000
Wolf and Lyons creeks, Wolf Creek, Mont			5,000
Stickney Creek, Craig, Mont			2,000
Dearborn River, Craig, Mont			2,000
Clear Creek, Chinook, Mont			2,000
Boxelder Creek, Chinook, Mont			2,000
Spring Pond, Pondera, Mont			1,000
Shankin Creek, Fort Benton, Mont			5,000
Highwood Creek, Fort Benton, Mont			3,000
Prickly Pear Creek, Johns Tank, Mont			5,000
Canyon Creek, Johns Tank, Mont			5,000
Belt Creek, Belt, Mont			5,000
Spring Creek and Pond, Logan, Mont			5,000
Sage Creek, Harlowton, Mont			7,000
Clear Creek, Havre, Mont			3,000
McDonald Creek, Lewiston, Mont			8,000
Reservoir, Scribner, Mont			5,000
Hutton Lake, Troy, Mont			4,000
Whitmore Lake, Shelby Junction, Mont			4,000
Trout Lake, Marion, Mont			2,000
Little Bitter Root Lake, Marion, Mont			2,000
Fish Pond, Sappington, Mont			2,000
Belt Creek, Neihart, Mont			4,000
Cottonwood Lake, Bernice, Mont			5,000
Belt, Hound, and Sheep creeks, Great Falls, Mont			10,000
Strawberry Creek, Chester, Mont			5,000
Lo Lo River, Missoula, Mont			7,000
Little Peoples Creek, Harlen, Mont			5,000
Joiners Lake, Sweet Grass, Mont			1,000
Beaver and Wagner creeks, Helena, Mont			10,000
Surprise Creek, Stanford, Mont			5,000
Big Spring Creek, Harlowton, Mont			9,000
Hot Springs Creek, Clancey, Mont			4,000
Bridger Creek in Gallatin County, Mont			10,000
Stone Creek in Gallatin County, Mont			10,000
East Gallatin River, Gallatin County, Mont			10,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Black-spotted trout—Continued.			
Trout Ponds, Twodot, Mont			9,500
Grayling Fish Pond, Gallatin County, Mont		10,000	
Elk Creek, Rogue River, Oreg		60,000	
Rogue River, Rogue River, Oreg		20,900	
Upper Spearfish Creek, Elmore, S. Dak			40,000
East Fork, Spearfish Creek, Elmore, S. Dak			20,000
Little Elk Creek, Piedmont, S. Dak			15,000
Whitewood Creek, Englewood, S. Dak			30,000
South Fork, Little Rapid Creek, Rochford, S. Dak			15,000
Crow Creek, Spearfish, S. Dak			10,000
Spearfish Creek, Spearfish, S. Dak			85,000
Beaver Creek, Spearfish, S. Dak			10,000
Sunderlands Pond, Spearfish, S. Dak			5,000
Spring Creek, Rapid City, S. Dak			15,000
Rapid Creek, Rapid City, S. Dak			107,500
Bennetts Pond, Rapid City, S. Dak			7,500
Lime Creek, Rapid City, S. Dak			2,500
Upper Rapid Creek, Rochford, S. Dak			15,000
Little Rapid Creek, Rochford, S. Dak			60,000
Elk Creek, Roubaix, S. Dak			37,500
Horse Creek, Hill City, S. Dak			4,900
Iron Creek, Hill City, S. Dak			10,000
Upper Iron Creek, Hill City, S. Dak			10,000
Fish Pond, Whitewood, S. Dak			10,000
Little Spearfish Creek, Spearfish Falls, S. Dak			20,000
Willow Creek Pond, Bellefourche, S. Dak			5,000
De Orville Creek, Colville, Wash			2,000
Mill Creek, Colville, Wash			2,000
Hatch Lake, Colville, Wash			1,000
White Lake, Colville, Wash			2,000
South Fork Stillaqualmish River, Everett, Wash			10,000
Trout Brook, Milan, Wash			1,500
Blake Lake, Milan, Wash			2,000
Fish Lakes, Newport, Wash			6,500
Blanchard Creek, Newport, Wash			1,500
Bonanza Creek, Newport, Wash			1,500
Lake Chelan, Wenatohee, Wash			2,000
Wide Hollar Creek, North Yakima, Wash			2,000
Siwash Creek, Tacoma, Wash			3,000
Holls Lake, Davenport, Wash			4,000
Bead Lake, Newport, Wash			5,000
Eagle Lake, Newport, Wash			5,000
Jared Lake, Newport, Wash			3,000
Columbia River, Newport, Wash			3,000
Dome Lake, Sheridan, Wyo			13,000
S. Jaffe, Rittergut, Germany	20,000		
Total	20,000	200,900	2,528,800
Brook trout:			
California Fish Commission, Verdi, Nev	200,000		
Trout Pond, Claremont, Colo			2,500
Trout Pond, Burlington, Colo			2,000
North Elk Creek, Pine Grove, Colo			8,000
Teller Lake, Black Hawk, Colo			25,000
Cottonwood Ponds, Parlin, Colo			2,000
North Fork Cache la Poudre River, Hermosa, Colo			5,000
Lake Alice, Thomasville, Colo			5,000
Leavenworth Creek, Georgetown, Colo			9,500
Big Thompson Creek, Lyons, Colo			4,750
Trout Lake, Wolcott, Colo			2,000
Bison Creek, Clyde, Colo			15,000
Small Lake, Busk, Colo			8,000
Fryingpan River, Ivanhoe, Colo			5,000
Norrie, Colo			20,000
Pine Creek, Fairview, Colo			10,000
Beaver Creek, Ward, Colo			10,000
Trout Brooks, Carbondale, Colo		10,000	
Platte River between Grant and Platte Canyon, Colo			25,000
Rock Creek, Leadville, Colo			4,000
Grand Lake, Grand Lake, Colo			3,950
Nailor Lake, Georgetown, Colo			1,000
Gould Creek, Saderlind, Colo			5,000
Canon Creek, Glenwood, Colo			15,000
Arkansas River, Leadville, Colo			3,000
Rock Creek, Leadville, Colo			3,000
Wellington Lake, Estabrook, Colo			25,000
Trout Lakes, Aspen, Colo			50,000
Trout Lake, Leadville, Colo			25,000
Lake Creek, Leadville, Colo			2,000
Troutdale Pond, Boulder, Colo		10,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Lake Lincoln, Idaho Springs, Colo		5,000	
Lake Stewart, Idaho Springs, Colo		5,000	
Lake Ohman, Idaho Springs, Colo		5,000	
Lake Reynolds, Idaho Springs, Colo		5,000	
Silver Lake, Idaho Springs, Colo		5,000	
Chicago Creek, Idaho Springs, Colo		10,000	
St. Marys Lake, Idaho Springs, Colo		5,000	
Lake Lomond, Idaho Springs, Colo		5,000	
Ohio Creek, Gunnison, Colo		15,000	
Gunnison River, Gunnison, Colo		15,000	
Tomiche River and Quartz Creek, Parlin, Colo		15,000	
Trout Lake, Buena Vista, Colo		5,000	
Lake Alicia, Thomasville, Colo		5,000	
Hunter Creek, Aspen, Colo		15,000	
Willow Lake, Aspen, Colo		10,000	
Big Thompson River, Loveland, Colo		15,000	
Lakes and Reservoir, Loveland, Colo		10,000	
Mitchell Lake, Fort Collins, Colo		10,000	
Spring Creek, Gunnison, Colo		15,000	
Baker Lake, Jefferson, Colo		5,000	
Platte River, between Grant and Bailey, Colo		50,000	
Chase, Colo		9,000	
Cassells, Colo		6,000	
Buffalo, Colo		3,000	
Stroutia Springs, Colo		6,000	
Webster, Colo		6,000	
South Platte River, South Platte, Colo		30,000	
Buffalo, Colo		15,000	
Bailey, Colo		6,000	
Estabrook, Colo		3,000	
Buffalo Creek, Buffalo, Colo		15,000	
Rock Creek, Insmont, Colo		15,000	
Black Lake, Wheeler, Colo		15,000	
North and South Forks, St. Vrain Creek, Lyons, Colo		65,000	
Middle Fork, St. Vrain Creek, Lyons, Colo		15,000	
Strawberry Lake, Weston, Colo		10,000	
North Fork of Geneva Creek, Cassells, Colo		15,000	
Streams in Deer Creek Park, Baileys, Colo		25,000	
Wellington Lake, at Wellington Lake, Colo		600,000	
Fryingpan River, between Norrie and Ruedi, Colo		50,000	
Dallas River, Ridgway, Colo		25,000	
Lake Eldora, Eldora, Colo		61,100	
Middle Bison and Beaver Creeks, Clyde, Colo		25,000	
Rio Grande River, Wagonwheel Gap, Colo		25,000	
Eagle River, Berrys Station, Colo		25,000	
Trout Pond, Montevista, Colo		25,000	
Musgrove Lake, Lake County, Colo		12,000	
Hourglass Lake, Larimer County, Colo		70,000	
Ridgway Ponds, Salida, Colo		58,100	
Fish Pond, Basalt, Colo		5,000	
Box Brook, Hartford, Conn			1,500
Trout Brook, East Hampton, Conn			1,000
Spring Pond, Branchville, Conn			800
East Mountain Reservoir, Waterbury, Conn			1,000
Trout Pond, Zoological Park, D. C			100
Wolf Lodge Creek, Cœur d'Alene, Idaho			1,500
Robinson Creek, Hailey, Idaho			2,000
Spring Creek, Market Lake, Idaho			2,000
Lake Brook, Peck Station, Idaho			500
North Fork Big Lost River, Mackay, Idaho			2,000
Cedar Creek, Mackay, Idaho			1,500
Pass Creek, Mackay, Idaho			1,500
Portneuf Creek, Pebble, Idaho			1,000
Fish Ponds, Orofino, Idaho			1,000
Potlatch Creek, Kendrick, Idaho			1,500
Club Springs, Soda Springs, Idaho			1,500
Big Lost River, Lost River, Idaho			2,000
Spring Branch, Manchester, Iowa		5,000	395
Village Creek, Lansing, Iowa		25,000	
Clear Creek, Lansing, Iowa		25,000	
Maquoketa River, Forestville, Iowa		20,000	
Canoe Creek, Decorah, Iowa		25,000	
Rowe Ponds, Bingham, Me		20,000	15,000
Mooselucmaguntic Lake, Bemis, Me			7,500
Lake Cobbosseecontee, Winthrop, Me			7,500
Little Tunk Pond, Tunk Pond, Me			7,500
Half Moon Creek, Knox, Me		30,000	7,500
Donnells Pond, Franklin, Me		20,000	7,500
Clearwater Pond, Farmington, Me			7,500
Varnum Pond, Farmington, Me		20,000	
Cargill Lake, Thorndike, Me			7,500

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Sandy Stream, Unity, Me			7,500
Narragaugus Pond, Hancock, Me			12,000
Green Lake, Otis, Me		75,000	28,137
Cargill Pond, Liberty, Me		20,000	
St. Georges Lake, Liberty, Me		20,000	
Duck Brook and Pond, Bar Harbor, Me		20,000	
Phillips Lake, Dedham, Me		30,000	
Branch Pond, Dedham, Me		50,000	
Morrison Pond, Dedham, Me		15,000	
Salmon Lake, Belgrade, Me		30,000	
Canaan Lake, Camden, Me		50,000	
Spectacle Pond, Shirley, Me		20,000	
Sebago Lake, Sebago Lake, Me		100,000	
Rowes Pond and Mill Brook, Cumberland, Me		10,000	
Georges River, Searsmont, Me		35,000	
Embden Lake, North Anson, Me		20,000	
Lake Anasagunticook, Canton, Me		20,000	
Squaw Pan Lake, Presque Isle, Me		35,000	
Gull Pond, Phillips, Me		20,000	
Gunball and Trip ponds, East Brownfield, Me		15,000	
Trout Brook, Waldoboro, Me		20,000	
Patten Pond, Ellsworth, Me		50,000	
Cathana Brook, Charlotte, Me		15,000	
Meadow Brook, Calais, Me		17,500	
Pennamaquam Brook, Calais, Me		17,500	
Molasses and Webb ponds, Franklin, Me		15,000	
Little Houston Pond, Katahdin, Me		50,000	
Parmachenee Club, Camp Caribou, Me	50,000		
Maine Fish Commission, Greenville Junction, Me	300,000		
Carroll Run, Glencoe, Md			300
Brookdale Brook, Glencoe, Md			300
McLane Run and Pond, Oakland, Md			600
Brownings Dam, Oakland, Md			1,200
Coonenessett Brook, Falmouth, Mass			1,000
Lebine Creek, Dunstable, Mass			2,000
Lake Quinsigamond, Worcester, Mass		24,975	
Trout Ponds, Worcester, Mass			24
Massachusetts Fish Commission, Wilkinsonville, Mass	35,000		
Hadley, Mass	35,000		
Tehanto Club, Wenaumet, Mass	5,000		
Spring Creek, Milford, Mich		10,000	
Cleveland Creek, Muskegon, Mich		20,000	
Silver Creek, Muskegon, Mich		20,000	
Cedar Creek, Muskegon, Mich		20,000	
Little Rainey and Indian rivers, Millersburg, Mich		30,000	
Ziegenfus Lake, Greenville, Mich		20,000	
Harper Creek, Schoolcraft, Mich		20,000	
Spring Brook, Kalamazoo, Mich		30,000	
Asylum Creek, Kalamazoo, Mich		20,000	
Portage Creek, Kalamazoo, Mich		20,000	
Benson Creek, Mount Morris, Mich		20,000	
Tillula Lake, Grayling, Mich		40,000	
Brush Creek, Alpena, Mich		40,000	
Little Wolf Creek, Alpena, Mich		10,000	
Simmons and Newton creeks, Alpena, Mich		10,000	
Bear and Wells creeks, Alger, Mich		10,000	
Trout and Swan rivers, Metz, Mich		30,000	
Coldwater Creek, Farwell, Mich		15,000	
North Branch Tobacco River, Clare, Mich		16,000	
Muskegon River, Evart, Mich		10,000	
Baldwin, Bowman, and Blood creeks, Baldwin, Mich		20,000	
Sandborn Creek, Nervina, Mich		10,000	
Cedar and Coldwater creeks, Wingleton, Mich		25,000	
Weldon and Ram creeks, Branch, Mich		10,000	
Hanson Creek, Ludington, Mich		10,000	
Cedar Creek, Manton, Mich		25,000	
Boardman River, South Boardman, Mich		25,000	
Kalkaska, Mich		35,000	
Maple River, Pellston, Mich		40,000	
Hale Lake and Silver Creek, Emory Junction, Mich		60,000	
Johnson Creek, East Tawas, Mich		40,000	
Pine River, Au Sable, Mich		30,000	
Cedar Creek, Greenbush, Mich		20,000	
Sturgeon River, Gaylord, Mich		125,000	
South Branch Paint Creek, Oxford, Mich		2,500	
Thurston Brook, Oxford, Mich		2,500	
Wright and Gravel creeks, Greenville, Mich		10,000	
Spring Brook, Northfield, Minn			500
Cook Valley Brook, Kellogg, Minn			300
Camp Creek, Preston, Minn			300
Johnson Creek and Lake, Nickerson, Minn		14,500	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Little River, Thief River Falls, Minn		15,000	
Lester River, Duluth, Minn		15,000	
Beaver River, Beaver Bay, Minn		14,500	
Rocky Run, Carson, Minn		14,500	
Missouri Fish Commission, St. Joseph, Mo	30,000		
Lake Finney, Bozeman, Mont			1,500
Sixteen-mile Creek, Baker Station, Mont			2,000
Sage Creek, Lewiston, Mont			1,500
Spring Pond, Lewiston, Mont			1,000
Fish Pond, Bozeman, Mont			3,500
Private ponds, Emigrant, Mont			1,500
Lake Palmer, Butte, Mont			2,000
Poindexter Creek, Dillon, Mont			1,000
Sage Creek, Harlowton, Mont			4,000
Comet Pond, Boulder, Mont			2,000
Highore Creek, Boulder, Mont			2,000
Little Boulder Creek, Boulder, Mont			2,000
Mount View Park Lake, Anaconda, Mont			2,000
Judith River and tributaries, Lewiston, Mont			5,000
Tributary of Yellowstone River, Livingston, Mont			1,000
Big Boulder Creek, Big Timber, Mont			5,000
Trail Creek, Martinsdale, Mont			1,500
South Fork Musselshell River, Freemans, Mont			5,000
Deep Guyson and Ray creeks, Townsend, Mont			2,000
North Fork Sun River, Wolf Creek, Mont			2,000
Johnson Creek, Armington, Mont			2,000
Silver Bow Creek, Silverbow Junction, Mont			1,000
Twin Lakes, Silverbow Junction, Mont			1,000
Weybert Creek, Lewiston, Mont			1,500
Bridger Creek, Gallatin County, Mont			15,000
J. F. Comee, Victor, Mont	10,000		
Nebraska Fish Commission, Southbend, Nebr	50,000		
Trout ponds and stream, West Springfield, N. H			2,000
Trout brooks, Concord, N. H			2,500
Thompson and Dudley brooks, Exeter, N. H			2,000
Goodwin Brook, Farmington, N. H			2,000
Wild Meadow Pond and brooks, Grafton, N. H		25,000	2,500
Trout brooks, Milford, N. H			2,000
Wentworth Lake, Nashua, N. H			2,000
Chase Brook, Nashua, N. H			2,000
Brickyard Brook, Nashua, N. H			2,000
Fish Pond, Nashua, N. H			1,000
Nanticook Brook, Nashua, N. H			300
Witch and Peacock brooks, Nashua, N. H			1,200
Lydia Reed Creek, Nashua, N. H		20,000	
Greenough Pond, Errol, N. H			2,490
Mountain Trout Brook, Dublin, N. H			2,000
West Branch Stream, Bradford, N. H			2,000
Trout brooks, Lancaster, N. H			2,000
Crawford Brook, Fabyan, N. H			2,000
Surry Brook and Pond, Surry, N. H			2,000
Trout streams, Somersworth, N. H			2,000
Mad River, Waterville, N. H			2,000
Mill Brook, Warner, N. H			2,000
Osgood and Meadow brooks, Warner, N. H		15,000	
Cole Pond, Potter Place, N. H		20,000	2,500
Ragged Mountain Pond, Potter Place, N. H			2,000
Brown Creek, Bristol, N. H			2,000
Trout Pond, Bristol, N. H			2,000
Beverley Brook, Portsmouth, N. H			2,000
Damon Brook, Manchester, N. H		15,000	2,000
Bowman Brook, Manchester, N. H		15,000	2,000
Manter Brook, Manchester, N. H		15,000	2,500
Sweetwater Brook, Manchester, N. H			1,500
Tannery Brook, Manchester, N. H		26,000	
Watts Brook, Manchester, N. H		15,000	
Little Pond, Concord, N. H			2,000
Dan Hole Pond, Moultonville, N. H			1,500
Lake Sunapee, Newbury, N. H			4,800
New London, N. H			2,200
Lake Gloriette, Colebrook, N. H			8,998
Tributary Souhegan River, Greenville, N. H			2,000
Brickyard Brook, Litchfield, N. H			600
Peacock Brook, Amherst, N. H			300
Witch Brook, Hollis, N. H			600
Fish Pond, Hudson, N. H			600
Wentworth Lake, Hudson, N. H			237
Rideoute and Howe brooks, Hollis, N. H			600
Trout ponds, Wentworth, N. H		15,000	
Swift River and James Pond, West Ossipee, N. H		30,000	
Ponds and streams, Newport, N. H		34,800	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Roaring Brook, Harrisville, N. H		20,000	
Rum and Tom Farm brooks, Epping, N. H		20,000	
Fish Pond, Groveton, N. H		14,800	
Crowley Pond, Concord, N. H		10,000	
Promise Pond, Chatham, N. H		20,000	
Johnson Brook, Orford, N. H		14,990	
N. B. Noyes, Colebrook, N. H	10,000		
New Hampshire Fish Commission, Colebrook, N. H	50,000		
Pond and stream, Morris Plains, N. J			300
A. M. Bigelow, Branchville, N. J	20,000		
Twitchell Creek, Beaver River, N. Y			1,000
County Brook, West Cambridge, N. Y			550
Mount View Lake, Acre, N. Y			300
Owego and Sawyer creeks, Owego, N. Y			300
Pharsalia Creek, Norwich, N. Y			300
Sauquoit Creek, Richfield, N. Y			300
Wheeler and Crandall brooks, Green, N. Y			300
Trout Pond, Roslyn, N. Y			350
Cathetacane Creek, Little Falls, N. Y			300
Nordrach Lake, Phœnicia, N. Y			300
Skinner and Lynza creeks, Mannsville, N. Y		15,000	
Longfellow Lake, Pleasant Lake, N. Y		20,000	
Henry and Budlong creeks, Frankfort, N. Y		10,000	
Beaver River, Beaver River, N. Y		10,000	
Salmon River, Williamstown, N. Y		25,000	
Beaverkill River, Livingston Manor, N. Y		20,000	
Carleton Ponds, Cape Vincent, N. Y		22,000	
Richmondville Creek, Richmondville, N. Y		10,000	
Poultney River, Raceville, N. Y		10,000	
Wiscoy Creek, Bliss, N. Y		10,000	
Sinclair Reservoir, West Point, N. Y		10,000	
Peekskill Hollow Brook, Peekskill, N. Y		10,000	
Schroon Lake, Riverside, N. Y		10,000	
Tributary of Owlkill Creek, Cambridge, N. Y		5,000	
Marky Blanchard and Killum creeks, Carthage, N. Y		20,000	
Chitola Lake, Lenoir, N. C			300
Maurey Creek, Coalville, N. C			300
Boyd Fork Creek, Morganton, N. C			300
Briar Fork of Little River, Davidson River, N. C			800
Little River, Davidsons River, N. C			800
Reason Over Creek, Davidsons River, N. C			800
Reems Creek, Asheville, N. C			500
Bee Tree Creek, Asheville, N. C			500
Sand Lake, Pleasant Lake, N. Dak			300
Pleasant Lake, Pleasant Lake, N. Dak			200
Horseshoe Lake, Dickinson, N. Dak			200
Trout Pond, Portland Junction, N. Dak			200
Spring Ponds, Bellefontaine, Ohio		10,000	
Bradsmith Springs, Bellefontaine, Ohio		10,000	
Spring Lake, Wickliff, Ohio		15,000	
Great Heart Lake, Woodstock, Ohio		5,000	
Mill Brook, Chardon, Ohio		25,000	
Reed Pond, Mentor, Ohio		5,000	
Fish Lake, Baker City, Oreg		4,995	
Clover Creek, Altoona, Pa			300
Spring Run, Altoona, Pa			300
Logan Branch, Bellefonte, Pa			600
Spring Run, Bellefonte, Pa			1,200
Fishing Creek, Bellefonte, Pa			300
Laurel Run, Bellefonte, Pa			200
Marsh Creek, Bellefonte, Pa			200
Mosquito Creek, Williamsport, Pa			1,100
Sugar Run, Williamsport, Pa			400
Rock Run, Williamsport, Pa			400
Gregs Run, Williamsport, Pa			200
East Branch, Honesdale, Pa		10,000	900
Old Log Cabin Creek, Honesdale, Pa		10,000	
Dybury Creek, Honesdale, Pa		5,000	
Hamlin Creek, Honesdale, Pa		5,000	
Lackawaxen Creek, Honesdale, Pa		10,000	
Boyd Creek, Honesdale, Pa		10,000	
Calkins Creek, Honesdale, Pa		5,000	300
Roots Creek, Honesdale, Pa		15,000	
Big Brook, Honesdale, Pa			300
Tributary of Clarion River, Foxburg, Pa			400
Carpenter Spring, Germantown, Pa			500
Fall Brook, Columbia Crossroads, Pa			200
Griffith Creek, Columbia Crossroads, Pa			200
Fellows Creek, Columbia Crossroads, Pa			200
Loyal Sock Creek, Laporte, Pa			500
Trout Pond, Loretta, Pa			200

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Daniels Brook, Ulysses, Pa			1,000
Gilhausen Run, Indiana, Pa			300
Furnace Run, Ligonier, Pa			300
Linns Run, Ligonier, Pa			300
Tributary of Darby Creek, Lansdowne, Pa			500
Herkiman Creek, Hamburg, Pa			300
Snyder Creek, Ebensburg, Pa			300
Wyomissing Creek, Reading, Pa			300
Willbach Spring Stream, Sheridan, Pa			300
Rattling Creek, Lebanon, Pa			300
Still Creek, Tamaqua, Pa			300
Hartung Run, Pottsville, Pa			300
Tar Run, Pottsville, Pa			600
Rausher Creek, Hamburg, Pa			300
Moselin Springs, Hamburg, Pa			200
Penns Creek, Rising Spring, Pa			400
Rattlesnake Run, Weathem, Pa			400
Club Creek, Weathem, Pa			400
Laurel Run, Ridgway, Pa			200
Bethany Creek, Womelsdorf, Pa			200
Fish Pond, Shenandoah, Pa			300
Evans Run, Marietta, Pa			800
Clover Creek, Martinsburg, Pa			300
Cold Run Creek, Middleport, Pa			300
Cabin Branch, Hellam, Pa			300
Clear Shade Creek, Johnstown, Pa			500
Crystal Run, Frackville, Pa			600
Little Mahanoy Creek, Frackville, Pa			300
Tar Run, Frackville, Pa			300
Bony Creek and Letort Spring, Carlisle, Pa			400
Stony Creek, Frackville, Pa			300
Fishing Creek, Jamison City, Pa			500
Swiftwater Creek, Mount Pocono, Pa			400
Meadow Creek, Loraine, Pa			300
Cold Run, Pottsville, Pa			600
Tumbling Run, Pottsville, Pa			600
Indian Run, Pottsville, Pa			300
Sheafers Creek, Pottsville, Pa			300
Schwartz Creek, Pottsville, Pa			300
Bear Creek, Pottsville, Pa			300
Big Creek, Pottsville, Pa			300
Bullard Creek, Troy, Pa			300
Morgan Creek, Troy, Pa			400
Webler Creek, Troy, Pa			100
Fellows Creek, Troy, Pa			300
Tioga River, Troy, Pa			300
Kiff Run, Troy, Pa			100
Dry Run, Troy, Pa			100
Falls Creek, Troy, Pa			200
Queens Run, Lockhaven, Pa			1,050
Craigs Fork Creek, Lockhaven, Pa			1,050
Rams Hollow Creek, Lockhaven, Pa			450
Lick Run, Lockhaven, Pa			1,050
Chatham Run, Lockhaven, Pa			600
Fishing Creek, Lockhaven, Pa			450
Cedar Run, Lockhaven, Pa			150
Hyner Run, Lockhaven, Pa			300
Fish Pond, Altoona, Pa			200
Pond and stream, Chestnut Hill, Pa			500
Canawacta Creek, Susquehanna, Pa		25,000	
Hemlock Creek, Susquehanna, Pa		10,000	
Big Hemlock Creek, Susquehanna, Pa		15,000	
Drinker Creek, Susquehanna, Pa		5,000	
Starrucca Creek, Susquehanna, Pa		10,000	
Cold Spring Creek, Susquehanna, Pa		15,000	
Brushville Creek, Susquehanna, Pa		5,000	
Swamp Spring Brooks, Hawley, Pa		10,000	
Starrucca Creek, Starrucca, Pa		5,000	
Pearl Creek, Huron, S. Dak			300
Bailey Creek, Wilmot, S. Dak			300
Spearfish Creek, Spearfish, S. Dak		52,500	3,000
False Bottom Creek, Spearfish, S. Dak			1,500
Spring Creek, Spearfish, S. Dak			1,500
Higgins Gulch Creek, Spearfish, S. Dak			1,500
Bare Butte Creek, Galena, S. Dak			1,250
Little Rapid Creek, Nahant, S. Dak			4,500
Whitewood Creek, Englewood, S. Dak			3,000
Upper Spearfish Creek, Englewood, S. Dak			1,500
Upper Spearfish Creek, Elmore, S. Dak			4,500
Little Rapid Creek, Rochford, S. Dak		15,000	6,000
Sylvan Lake, Custer, S. Dak			1,500

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Rapid Creek, Rapid City, S. Dak		15,000	4,000
Leamans Pond, Rapid City, S. Dak		12,000	
Spring Creek, Hill City, S. Dak		25,000	1,500
Grizzly Creek, Hill City, S. Dak			1,500
Elk Creek, Roubaix, S. Dak		40,000	1,250
Squaw Creek, Maurice, S. Dak		10,000	2,000
Castle Creek, Rochford, S. Dak			1,500
North Castle Creek, Rochford, S. Dak		20,000	
Rosebud Creek, Rosebud, S. Dak		15,000	
Beads Creek, Rosebud, S. Dak		15,000	
Tollgate Creek, Spokane, S. Dak		20,000	
West Branch Pattee Creek, Hudson, S. Dak		20,000	
Box Elder Creek, Nemo, S. Dak		15,000	
Silver Creek, Sturgis, S. Dak		30,000	
Watercress Creek, Spearfish, S. Dak		20,000	
Bare Butte Creek, Roubaix, S. Dak		20,000	
Crow Creek, Spearfish, S. Dak		30,000	
Coker Creek, near Spearfish, S. Dak		5,000	
Chicken Creek, near Spearfish, S. Dak		5,000	
Little Spearfish Creek, Spearfish Falls, S. Dak		40,000	
East Fork Spearfish Creek, Englewood, S. Dak		15,000	
Franklin Branch, Spearfish, S. Dak		18,000	
Little Elk Creek, Piedmont, S. Dak		10,000	
Doak and Davis creeks, Greenville, Tenn			500
Tumbling Creek, Earnestville, Tenn			1,000
Mill Creek, near Salt Lake City, Utah			3,000
Utah Fish Commission, Murray, Utah	50,000		
Carpenter Brook and Brown Pond, West Waterford, Vt			5,000
Lake Lakota, Woodstock, Vt			2,500
Shrewsbury Pond, Cuttingsville, Vt			2,000
Trout Pond, West Hartford, Vt			2,071
Frost Pond, Brattleboro, Vt			2,000
Small Brook, St. Johnsbury, Vt			550
Leach Ponds, Averill, Vt			3,995
Lake Mitchell, Sharon, Vt			2,497
Small Brook, Manchester, Vt			1,998
Frog Pond, West Waterford, Vt		15,000	
Niggerhead Brook, Marshfield, Vt		15,000	
Holland Pond, Derby Line, Vt		20,000	
Denning Brook, Arlington, Vt		10,000	
Sterling Pond, Johnson, Vt		15,000	
Fairchild Pond, Guildhall, Vt		15,000	
Ice Pond, Barton Landing, Vt		5,000	
South and Middle Hollow Brooks, Bethel, Vt		20,000	
Pond and Stream, St. Johnsbury, Vt		5,000	
Mafeba Lake, Randolph, Vt		10,000	
Griffith Trout Pond, Danby, Vt		20,000	
Branch of Otter Creek, Danby, Vt		20,000	
Spring Brook, Rutland, Vt		20,000	
Trout Pond, North Underhill, Vt		10,000	
Willis, Lee and Crane Brooks, Jericho, Vt		15,000	
Furnace and Sugar Hollow Brooks, Pittsford, Vt		20,000	
Hewitt and Ridley Brooks, Middlebury, Vt		10,000	
Haskins Brook, Middlebury, Vt		10,000	
Black Pond, Woodstock, Vt		20,000	
Meccawe Pond, Woodstock, Vt		20,000	
Lakota Lake and Stream, Woodstock, Vt		25,000	
Tucker Brook, Woodstock, Vt		15,000	
Whitstone Brook, Brattleboro, Vt		24,990	
Trout Ponds, Brattleboro, Vt		29,990	
Deerfield Tributaries, Wilmington, Vt		14,975	
Bean Pond, St. Johnsbury, Vt		10,000	
Ampampanoosac Creek, Sharon, Vt		20,000	
Pomfret Brook, West Hartford, Vt		15,000	
Lone Lane Brook, Chester, Vt		9,995	
Dog River, Northfield, Vt		20,000	
Ayers Brook and Mud Pond, Randolph, Vt		10,000	
Pith Brook, Randolph, Vt		10,000	
Clay, Stevens, and Crane Brooks, Underhill, Vt		15,000	
Martin Brook, Montpelier, Vt		10,000	
Parmenter Brook, Montpelier, Vt		10,000	
Langdon Pond, Montpelier, Vt		10,000	
Salmon Brook, Dummerston, Vt		15,000	
North Branch of Ottauquechee River, Woodstock, Vt		15,000	
May Pond, Barton, Vt		20,000	
Lakota Pond, White River Junction, Vt		10,000	
Battenkill Creek, Manchester, Vt		20,000	
Fall and Hawkins Brooks, Lyndonville, Vt		10,000	
Morton Brook, West Burke, Vt		10,000	
White River, Bethel, Vt		20,000	
Whitmore Brook, Springfield, Vt		20,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Hatch and Mason Ponds, Randolph, Vt		10,000	
Branch of White River, Williamstown, Vt		15,000	
Lowell Pond, Newbury, Vt		10,000	
Hollow Brook, Westminster, Vt		10,000	
Noyes Pond, Rutland, Vt		40,000	
Pond and Brook, Wells River, Vt		5,350	
Darling Pond, Groton, Vt		75,000	
Lake Mansfield, Stowe, Vt		75,000	
Lake Mitchell, West Norwich, Vt		100,000	
University of Vermont, Burlington, Vt	1,000		
Smith Creek, Clifton Forge, Va		30,000	300
Trout Pond, Martinsville, Va			400
Trout Pond, Mount Jackson, Va			200
Darbs Creek, Winchester, Va			300
Thornton River, Luray, Va			300
Thresher Creek, Amherst, Va			500
Fox Creek, Grant, Va			300
Dry River, Harrisonburg, Va			300
Trout Pond, Newcastle, Va			300
Mill Creek, Millboro, Va			6,300
Dry Run, Back Creek, and Cowardin Creek, Hot Springs, Va			8,750
Clinch River, Tazewell, Va			5,250
Tate Run, Wytheville, Va			1,945
Snake Den Creek, Hunters, Va			8,910
Back Creek, Hot Springs, Va			2,168
Cowardin Creek, Hot Springs, Va			2,166
Healing Springs, Hot Springs, Va			2,166
Tributaries Difficult Run, Vienna, Va		17,531	60
Iron Mountain and Castle Runs, Covington, Va		25,000	
Spring Branch, Walla Walla, Wash		4,997	1,500
Natcheese River, North Yakima, Wash			1,500
Spring Branch, North Yakima, Wash		9,997	1,000
Nelson Lake, Harrington, Wash			1,500
Black Lake, Belmore, Wash			1,450
Lake Langdon, East Sound, Wash			1,500
Oropochon Creek, Davenport, Wash			1,500
San Poil Creek, Republic, Wash			1,000
Deming Creek, Seattle, Wash			8,364
West Fork of White Salmon River, Hood River, Wash		4,998	
Trout Creek, Hood River, Wash		4,999	
Troublesome Creek, Madison, Wash		9,998	
Washtucna Lake, Kahlotus, Wash		7,496	
Fish Lake, Kanaskat, Wash		2,998	
Davidson Creek, Tacoma, Wash		10,000	
Spring Pond, Eglon, W. Va			800
Allegheny Run, Collins, W. Va			800
Clover Creek, Clover Lick, W. Va			1,500
Leatherbank Creek, Cass, W. Va			6,000
East Fork of Greenbrier River, Durbin, W. Va			9,000
Little Kanawha River, Burnsville, W. Va			2,250
Elk River, Holly Junction, W. Va			2,400
Addison, W. Va			1,500
Gauley River, Camden-on-Gauley, W. Va			4,650
Howard Creek, White Sulphur Springs, W. Va			2,730
Spring Branch, White Sulphur Springs, W. Va			1,300
Huddleston Branch, White Sulphur Springs, W. Va			780
Mans Creek, Sewell, W. Va			780
Laurel Creek, Sandstone, W. Va		20,000	
Cheat River tributaries, Durbin, W. Va		50,000	
Meadow Creek, Meadow Creek Station, W. Va		20,000	
Meadow Creek, Shryock, W. Va		10,000	
Glade Creek, Hinton, W. Va		25,000	
Dutch Run, Dutch Run, W. Va		10,000	
Upper Dry Creek, Tuckahoe, W. Va		5,000	
Rich Creek, Lowell, W. Va		5,000	
F. A. Degler, Huttonsville, W. Va	25,000		
Iron and Brule rivers, Marinette, Wis		30,000	400
Middle Inlet, Athelstane, Wis			200
Hay Creek, Augusta, Wis			100
Kirkham Creek, Augusta, Wis			125
Beef River, Augusta, Wis			100
Browns Creek, Augusta, Wis			100
Otter Creek, Augusta, Wis			50
Thompson Creek, Augusta, Wis			100
Rock Creek, Mondovi, Wis			50
Harvey Creek, Mondovi, Wis			50
Bennett Valley Creek, Mondovi, Wis			50
Hunters Creek, Mondovi, Wis			50
Scott Creek, Fairchild, Wis			100
Tracy Creek, Osseo, Wis			100
Kings Creek, Osseo, Wis			50

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Little Flora Creek, Tomah, Wis			150
Big Flora Creek, Tomah, Wis			75
Ford Creek, Tomah, Wis			50
Tar Creek, Tomah, Wis			75
South Branch Tar Creek, Tomah, Wis			150
North Branch Tar Creek, Tomah, Wis			75
Deer Creek, Tomah, Wis			75
Hyde Creek, Clintonville, Wis			50
Hogue Creek, Strum, Wis			100
Valley Creek, Strum, Wis			50
Otter Creek, Eau Claire, Wis			100
Beaver Creek, Eau Claire, Wis			100
Rock Creek, Eau Claire, Wis			100
Lowe Creek, Eau Claire, Wis			100
Kralls Creek, La Crosse, Wis			100
Coon Creek, La Crosse, Wis			200
Beaty Creek, Hixton, Wis			75
South Branch Creek, Hixton, Wis			75
Lowe Creek, Hixton, Wis			75
Pine Creek, Hixton, Wis			75
Shearwood Creek, Hixton, Wis			75
Sly Creek, Hixton, Wis			75
Fall Creek, Fall Creek, Wis			100
Bears Grass Creek, Fall Creek, Wis			100
Beaver Creek, Fall Creek, Wi			50
Squaw Creek, Sparta, Wis			75
Walrath Creek, Sparta, Wis			75
Silver Creek, Sparta, Wis			75
Beaver Creek, Sparta, Wis			75
Bailey Creek, Sparta, Wis			75
Big Creek, Sparta, Wis			75
Swamp Creek, Sparta, Wis			75
Sargent Creek, Sparta, Wis			75
Stockwell Creek, Merrillan, Wis			75
Wright Creek, Merrillan, Wis			75
Van Hersey Creek, Merrillan, Wis			75
Cisna Creek, Merrillan, Wis			75
Zeitz Creek, Black River Falls, Wis			75
Allen Creek, Black River Falls, Wis			75
Squaw Creek, Black River Falls, Wis			75
Chipmonk Cooley Creek, La Crosse, Wis		20,000	
Half Way Creek, La Crosse, Wis		20,000	
Morman Creek, La Crosse, Wis		20,000	
Prairie River, Merrill, Wis		20,000	
Reefer Creek, Bayfield County, Wis		14,500	
Ox Creek, Gordon, Wis		10,000	
Chain of Lakes, Waupaca, Wis		25,000	
Sand Creek, Beulah, Wyo		60,000	4,500
Blake Pond, Beulah, Wyo		10,000	
Tower Creek, Yellowstone Park, Wyo		15,000	
Headwaters of Gardiner River, above Golden Gate, Wyo		19,200	
Wyoming Fish Commission, Sheridan, Wyo	60,000		
Otto Grann, Laramie, Wyo	20,000		
Thomas E. Moore, Weimar, Germany	10,000		
Moreton Frewen, Innishannon, Ireland	25,000		
Total	986,000	6,306,774	806,211
Lake trout:			
Fryingpan River, between Nast and Thomasville, Colo			2,400
Lyde Lake, Ivanhoe, Colo		5,000	
Connecticut Fish Commission, Windsor Locks, Conn	250,000		
Lake Okoboji, Arnolds Park, Iowa		9,700	
Varnum Pond, Farmington, Me		13,523	
Sweet Pond, New Vineyard, Me		13,523	
Donnells Pond, Franklin, Me		13,600	
Trout Ponds, Worcester, Mass			100
Michigan Fish Commission, Paris, Mich	1,000,000		
Straits of Mackinac, Mackinaw City, Mich		1,170,000	
Lake Huron, Alpena, Mich		1,500,000	
Detour, Mich		500,000	
Off Presque Isle, Mich		800,000	
Off Scarecrow Island, Mich		800,000	
Off North Point, Mich		785,000	
Off East Tawas, Mich		630,000	
Lake Superior, Marquette, Mich		1,500,000	
Off Whitefish Point, Mich		1,100,000	
Todds Harbor, Mich		260,000	
Off Fish Island, Mich		280,000	
Tobins Harbor, Mich		220,000	
Rock Harbor, Mich		280,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Lake trout—Continued.			
Lake Superior, Long Point, Mich		280,000	
Washington Harbor, Mich		560,000	
Ontonagon, Mich		1,280,000	
Eagle Harbor, Mich		280,000	
Lake Michigan, off Gull Island, Mich		700,000	
Charlevoix, Mich		4,100,000	
Soo River, Sault Ste. Marie, Mich		425,000	
St. Marys River, Sault Ste. Marie, Mich		775,000	
Round Island, Mich		600,000	
Hay Lake, Sault Ste. Marie, Mich		600,000	
Lake Superior, Grand Marais, Minn		360,000	
Two Harbors, Minn		80,000	
Beaver Bay, Minn		140,000	
Poplar River, Minn		140,000	
Chicago Bay, Minn		360,000	
Grand Portage, Minn		360,000	
Norman, Minn		140,000	
Black River, Williamsville, Mo		900	
Connecticut River, West Stewartstown, N. H		31,695	8,951
Rocky Pond, Hollis, N. H		10,000	
Lake Winnepesaukee, Alton Bay, N. H		30,000	
Squaw Lake, Ashland, N. H		30,000	
Winnisquam Lake, Laconia, N. H		30,000	
Merry Meeting Lake, New Durham, N. H		10,000	
Newfound Lake, Bristol, N. H		30,000	
New Hampshire Fish Commission, Plymouth, N. H	475,000		
Colebrook, N. H	25,000		
Belknap County Fish and Gun League, Laconia, N. H	200,000		
M. B. Noyes, Colebrook, N. H	100,000		
New York Fish Commission, Mumford, N. Y	1,830,896		
Adirondack League Club, Fulton Chain, N. Y	200,000		
Tuxedo Club, Tuxedo Park, N. Y	30,000		
Battery Park Aquarium, Battery Park, N. Y	50,000		
Otsego Lake, Cooperstown, N. Y		60,881	
Lake Ontario, off Tibbits Light, N. Y		1,380,600	
Grenadier Island, N. Y		4,010,570	
Fox Island, N. Y		1,007,500	
St. Lawrence River, off Tibbits Point, N. Y		14,500	
Carleton Island, N. Y		5,000	
Crystal Lake, West Albany, N. Y		10,000	
Toxaway Club, Toxaway, N. C	25,000		
Lake Erie, Long Point Reef, off Kelley Island, Ohio		491,600	
Fish Lake, Haines, Oreg		2,990	
Spring Lake, Portland, Oreg		2,500	
Beaver Lake, Lincoln County, Oreg		6,000	
Harvey Lake, Alderson, Pa		15,000	
Pennsylvania Fish Commission, Corry, Pa	1,500,000		
Big Averill Lake, Averill, Vt		40,000	
Island Pond, Island Pond, Vt		20,000	
Maidstone Lake, Maidstone, Vt		30,000	
Caspian Lake, Greensboro, Vt		40,000	
Willoughby Lake, Westmore, Vt		48,000	
Vermont Fish Commission, Roxbury, Vt	300,000		
Benny Creek, Seattle, Wash			7,000
Pierre Lake, Orient, Wash			6,800
Lake Superior, Sand Island, Wis		280,000	
Bark Point, Wis		280,000	
Wisconsin Fish Commission, Madison, Wis	2,000,000		
Wyoming Fish Commission, Laramie, Wyo	200,000		
Lake Superior, Rossport, Ontario, Canada		300,000	
J. B. Feilding, Upper Downing, North Wales	50,000		
Charles L. E. Lardy, for Swiss Government, Havre, France	50,000		
Total	8,285,896	29,278,082	25,251
Lake herring:			
Lake Erie, Gull Island Reef, off Kelley Island, Ohio		1,500,000	
Scotch sea trout:			
Aquarium, Zoological Park, D. C			12
Heart Pond, East Orland, Me			52
Craig Pond, East Orland, Me			35
Toddy Pond, East Orland, Me			75
Tahanta Club, Wenaumet, Mass	2,500		
Total	2,500		174
Golden trout:			
Lake Sunapee, New London, N. H			4,200
Sunapee, N. H		16,825	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Canadian red trout:			
Caspian Lake, Greensboro, Vt			535
Hybrid trout:			
Lake Sunapee, New London, N. H			1,720
Grayling:			
South Platte River, Lidderdale, Colo		10,000	
Platte River, Insmont, Colo		15,000	
Eagle River, Berry Station, Colo		15,000	
Aquarium, Zoological Park, D. C			12
Phillips Lake, Lake House, Me		6,500	
Moosehorn Creek, Bucksport, Me		4,000	
Floods Creek, Surry, Me		3,300	
Dead Brook, Bucksport, Me		3,314	
Michigan Fish Commission, Paris, Mich	200,000		
Missouri Fish Commission, St. Joseph, Mo	85,000		
Basin Creek, Harlowton, Mont		50,000	
Cliff Lake, Madison, Mont		145,000	
Elk Creek and tributaries, Bozeman, Mont		692,000	
Swift Dimond Creek, Stewartstown, N. H		30,000	
Utah Fish Commission, Murray, Utah	100,000		
Caspian Lake, Greensboro, Vt			356
Wyoming Fish Commission, Sheridan, Wyo	60,000		
Total	445,000	974,114	368
White-fish:			
Lake Huron, North Point, Mich		11,000,000	
Thunder Bay Island, Mich		10,000,000	
Scarecrow Island, Mich		5,500,000	
Sturgeon Point, Mich		3,500,000	
Detour, Mich		5,000,000	
Lake Michigan, off Skulligillee, Mich		10,000,000	
Charlevoix fishing-grounds, Mich		10,000,000	
off Gull Island, Mich		5,000,000	
off Manistique, Mich		6,000,000	
Lake Superior, Marquette, Mich		6,000,000	
Fisherman's Home, Mich		1,600,000	
Grace Harbor, Mich		1,600,000	
Ontonagon, Mich		3,200,000	
Fourteen Mile Point, Mich		3,000,000	
Lake St. Clair, near Detroit, Mich		12,000,000	
Hay Lake, off Sugar Island, Mich		10,000,000	
Detroit River, off Belle Isle, Mich		30,250,000	
St. Mary River, 7 miles above Soo City, Mich		4,000,000	
near Whitefish Point, Mich		5,000,000	
near Point au Prince, Mich		5,000,000	
Flathead Lake, Kalispell, Mont		600,000	
Otsego Lake, Cooperstown, N. Y		257,000	
Lake Ontario, near Tibbits Point, N. Y		9,000,000	
Eastern End, N. Y		8,000,000	
near Grenadier Island, N. Y		7,000,000	
near Bear Point, N. Y		1,000,000	
New York Aquarium, Battery Park, N. Y	275,000		
Lake Erie, Buckeye Island Reef, off Put-in Bay, Ohio		5,000,000	
Ottawa Reef, off Put-in Bay, Ohio		5,000,000	
off Axtell Point Reef, Put-in Bay, Ohio		10,000,000	
off Big Chicken Reef, off Put-in Bay, Ohio		10,000,000	
North Bass Island Reef, off Put-in Bay, Ohio		10,000,000	
Honey Point Reef, off Put-in Bay, Ohio		10,000,000	
Stone Island Reef, off Put-in Bay, Ohio		11,125,000	
North Point, off Kelley Island, Ohio		10,000,000	
State Fish Commission, Erie, Pa	38,052,000		
Lake Champlain, West Swanton, Vt		450,000	
American Lake, Lakeview, Wash		137,020	
Lake Kapowsin, Lake Kapowsin, Wash		91,347	
Lake Ohod, Lake Kapowsin, Wash		45,673	
Lake Superior, off Aminicon River, Wis		1,600,000	
State Fish Commission, Madison, Wis	25,000,000		
Total	63,327,000	246,956,040	
Pike perch:			
Aspinook Reservoir, Jewett City, Conn		495,000	
Potomac River, Aqueduct Bridge, D. C		833,330	
Mississippi River, Savanna, Ill			100
Notre Dame Lake, South Bend, Ind		500,000	
Caldwell Lake, Claypool, Ind		250,000	
Beaver Dam Lake, Claypool, Ind		300,000	
Deaton Lake, Claypool, Ind		250,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pike perch—Continued.			
Car Lake, Claypool, Ind		300,000	
Homan Lake, Claypool, Ind		250,000	
Yellow Creek Lake, Claypool, Ind		300,000	
Mud Lake, Claypool, Ind		300,000	
Lake Manitou, Rochester, Ind		500,000	
Lake Maxinkuckee, Culver, Ind		8,200,000	
Cedar River, Waterloo, Iowa		400,000	
Big Turkey River, Calmar, Iowa		200,000	
Howard Pond, Corydon, Iowa		160,000	
Cedar River, Cedar Rapids, Iowa			50
Maquoketa River, Manchester, Iowa			150
Volga River, Volga, Iowa			15
Mississippi River, Gordon Ferry, Iowa			1,300
Bellevue, Iowa			700
Lanesville, Iowa			400
Mississippi River, McGregor, Iowa			500
Clayton, Iowa			500
Wapsipinicon River, Quasqueton, Iowa			200
Middle Fork Red River, Lexington, Ky		700,000	
Onota Lake, Pittsfield, Mass		498,000	
Goddard Pond, Worcester, Mass		499,000	
State Fish Commission, Wilkinsonville, Mass	5,000,000		
Northampton, Mass	5,000,000		
Crooked Lake, Watersmeet, Mich		600,000	
Thunder Bay, Alpena, Mich		1,000,000	
Lelanau Lake, Fouchs, Mich		1,000,000	
Lake Erie, Monroe, Mich		15,000,000	
State Fish Commission, Detroit, Mich	30,000,000		
Madison Lake, Madison Lake, Minn		200,000	
Lake Hendricks, Hendricks, Minn		200,000	
No Name Lake, Duluth, Minn		600,000	
Island Lake, Cromwell, Minn		600,000	
Duck Lake, Madison Lake, Minn		200,000	
Eagle Lake, Mankato, Minn		400,000	
Washington Lake, Mankato, Minn		200,000	
Maple Lake, Mentor, Minn		900,000	
Big Creek, Annapolis, Mo		800,000	
State Fish Commission, St. Joseph, Mo	10,000,000		
Swains Pond, Dover, N. H		500,000	
Susquehanna River, Binghamton, N. Y		800,000	
Rudd and Indian lakes, Millerton, N. Y		400,000	
Racket River, Potsdam, N. Y		400,000	
New York Aquarium, Battery Park, N. Y	1,500,000		
Hocking River, Nelsonville, Ohio		1,000,000	
Lake Erie, Middle Bass Island Reef, off Put-in Bay, Ohio		20,000,000	
off Port Clinton, Ohio		35,000,000	
North Bass Island Reef, off Put-in Bay, Ohio		10,000,000	
Green Island Reef, off Put-in Bay, Ohio		10,000,000	
off Put-in Bay, Ohio		975,000	
Susquehanna River, Susquehanna, Pa		800,000	
Crystal Lake, Carbondale, Pa		400,000	
Le Boeuf Creek, Waterford, Pa		800,000	
Middle Creek, Beavertown, Pa		400,000	
Silver Lake, Montrose, Pa		400,000	
Heart Lake, Heart Lake, Pa		250,000	
State Fish Commission, Erie, Pa	30,000,000		
Eastanalee River, Athens, Tenn		700,000	
Big Hosmer Pond, Hardwick, Vt		500,000	
Lake Greenwood, Hardwick, Vt		500,000	
Hall Pond, Concord, Vt		500,000	
Rescue and Echo Ponds, Ludlow, Vt		1,000,000	
Lake Morey, Fairlee, Vt		500,000	
Lamoille River, Cambridge Junction, Vt		1,000,000	
Groton Pond, Montpelier, Vt		1,000,000	
Silver Lake, Bethel, Vt		75,000	
Winoski River, Winoski, Vt		1,500,000	
Otter Creek, Vergennes, Vt		600,000	
Lake Champlain, Highgate Springs, Vt		1,000,000	
Missisquoi Bay, Vt		5,000,000	
St. Albans Bay, Vt		1,000,000	
McQuan Bay, Vt		500,000	
Missisquoi River, Highgate, Vt		1,000,000	
Swanton, Vt		437,203	
Shenandoah River, Woodstock, Va		1,666,670	
Drummond and Crystal lakes, Drummond, Wis		600,000	
Round Lake, Cartwright, Wis		300,000	
Nigger Lake, Medford, Wis		300,000	
Total	81,500,000	138,439,203	3,915

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Cat-fish:			
Brush Fish Pond, Seale, Ala			1,000
Private Pond, Seale, Ala			1,000
Lake Morris, Attalla, Ala			1,000
Lake Malone, Attalla, Ala			1,000
Fish Pond, Marion, Ala			2,000
Fish Pond, Hurtsboro, Ala			1,000
Fish Pond, Letohatchee, Ala			1,000
Mill Pond, Letohatchee, Ala			1,000
Fish Pond, Montgomery, Ala			1,000
Fish Pond, Ashford, Ala			500
Fish Pond, Fort Deposit, Ala			1,000
Fish Pond, Headland, Ala			500
Fish Pond, Culloden, Ga			800
Fish Pond, Thomson, Ga			800
Forest Pond, Conyers, Ga			500
Fish Pond, Oglethorp, Ga			500
Fish Pond, Lumpkin, Ga			500
Fish Pond, Hampton, Ga			500
Edgewood Pond, Atlanta, Ga			500
Park Lake, Atlanta, Ga			500
Spring Branch, Atlanta, Ga			1,000
Mill Pond, Weston, Ga			600
Fish ponds, Hawkinsville, Ga			1,000
Fish Pond, Macon, Ga			25
Okmulgee River, Macon, Ga			800
Grays Mill Pond, Macon, Ga			450
Fish Pond, Douglasville, Ga			500
Red Oak Creek, Neal, Ga			5,000
Cane Creek, Raleigh, Ga			5,000
Flint River, Woodbury, Ga			5,000
Fish Pond, Forsyth, Ga			500
Chattahoochee River, Columbus, Ga			10,000
Armstrong Lake, Washington, Ga			2,000
Bagley Pond, Americus, Ga			500
King Pond, Cusseta, Ga			800
Fish Pond, Lumpkin, Ga			500
McQuinter Pond, Sparta, Ga			150
Fish ponds, Clarkston, Ga			600
Fish Pond, Belmont, Ga			100
Fish Pond, Pecan, Ga			500
Gold Mine Ponds, Kenesaw, Ga			1,000
Albaugh Lake, Fort Valley, Ga			1,000
Fish Pond, Stone Mountain, Ga			1,000
Mill Pond, Fayetteville, Ga			500
Fish Pond, Bowmans, Ga			1,000
Fish Pond, Hull, Ga			1,000
Fish Pond, Lithonia, Ga			1,000
Fish Pond, Sunnyside, Ga			1,000
Fish Pond, Pomona, Ga			1,000
Mill Pond, Box Springs, Ga			1,000
Mississippi River, Savanna, Ill			500
Cedar River, Cedar Rapids, Iowa			3,000
Maquoketa River, Manchester, Iowa			1,000
Lake Nyanza, Grinnell, Iowa			200
Volga River, Volga, Iowa			2,930
Wapsipinicon River, Quasqueton, Iowa			1,900
Mississippi River, Bellevue, Iowa			28,000
Gordon Ferry, Iowa			25,500
Lanesville, Iowa			1,000
McGregor, Iowa			10,000
Clayton, Iowa			5,000
Lake Bertha, Bemidji, Minn			150
Fish Pond, Des Loge, Mo			200
Fish Pond, Pomona, Mo			200
Fish Ponds, Neosho, Mo			225
Hearalls Branch, Neosho, Mo			50,000
Sanitarium Ponds, Capitan, N. Mex			200
Vance Lake, San Antonio, Tex			50
Tygarts River, Mill Creek, W. Va			200
Mississippi River, Glen Haven, Wis			5,000
Minister of Agriculture, Brussels, Belgium			100
			200,380
Yellow perch:			
Potomac River, Bathing Beach, D. C	8,000,000		
Soldiers' Home Lake, Danville, Ill			3,000
Fish Pond, Whitehall, Ill			375
Fish Pond, Belleville, Ill			125
Fish Pond, Roodhouse, Ill			125

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry	Fingerlings, yearlings, and adults.
Yellow perch—Continued.			
Fish Pond, Jerseyville, Ill			125
Fish Ponds, Godfrey, Ill			250
Fish Ponds, Greenville, Ill			750
Fish Pond, Troy, Ill			125
Fish Pond, Summerville, Ill			125
Fish Pond, Lebanon, Ill			375
Reservoir, Galesburg, Ill			75
Mississippi River, Savanna, Ill			1,000
Bellevue, Iowa			7,000
Gordons Ferry, Iowa			5,000
Lanesville, Iowa			1,000
McGregor, Iowa			2,500
Clayton, Iowa			3,500
Glen Haven, Wis			5,000
Missisquoi River, Swanton, Vt		21,467,500	
Total	8,000,000	21,467,500	30,450
White perch:			
Swan Creek, Swan Creek, Md		1,492,000	
Chesapeake Bay, off Battery Island, Md		29,371,000	
New York Aquarium, Battery Park, N. Y	445,000		
Total	445,000	30,863,000	
Pike:			
Volga River, Volga, Iowa			15
Buffalo-fish:			
Mississippi River, Savanna, Ill			15,000
Bellevue, Iowa			60,000
Gordon Ferry, Iowa			50,000
Lanesville, Iowa			10,000
McGregor, Iowa			30,000
Clayton, Iowa			10,000
Glenhaven, Wis			25,000
Total			200,000

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass:	
Fletcher Lake, Opelika, Ala	2,000
Lake View Lake, Opelika, Ala	4,000
Ingram Mill Pond, Opelika, Ala	500
Cotton Mill Pond, Opelika, Ala	2,100
Marsh Pond, Enterprise, Ala	280
Artificial Lake, Collinsville, Ala	150
Reservoir, Ironaton, Ala	200
Fish Lake, Tuskegee, Ala	150
Perry Fish Pond, Tuskegee, Ala	450
Blackwater River, Jasper, Ala	3,700
Clear Creek, Jasper, Ala	400
Brick Yard Lake, Selma, Ala	300
Hogan Dam, Selma, Ala	300
Spring Branch, Scranage, Ala	150
City Reservoir, Attalla, Ala	150
Fish Lake, Attalla, Ala	300
Lake Washburn, Dothan, Ala	250
Park Lake, Dothan, Ala	250
Reeves Lake, Dothan, Ala	250
Riggins Lake, Dothan, Ala	150
Fish Pond, Dothan, Ala	250
Water Works Pond, Bessemer, Ala	300
Lookout Creek, Valleyhead, Ala	200
Wills Creek, Valleyhead, Ala	200
Pettus Lake, Eutaw, Ala	200
Fish Lake, Eutaw, Ala	100
Carter Lake, Montgomery, Ala	300
Tyson Fish Pond, Montgomery, Ala	300
Alabama River, Montgomery, Ala	300
Shoal Creek, Montevallo, Ala	300
Fish Lake, Renfroe, Ala	200
Mill Pond, Spruce Pine, Ala	150
Mountain Pond, Lincoln, Ala	150
Franklin Pond, Lincoln, Ala	150

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Spring Lake, Piedmont, Ala	200
Bay Pond, Benton, Ala	200
Mill Pond, Benton, Ala	100
Fish Pond, Andalusia, Ala	300
Schultz Creek, Centerville, Ala	300
Schrim Creek, Albertville, Ala	200
Beaver Creek Mill Pond, Whitney, Ala	200
Chattahoochee River, Alaga, Ala	100
Cedar Creek, Mount Vernon, Ala	100
Mill Pond, Brantley, Ala	450
Pea River and tributaries, Elba, Ala	800
Fish Pond, York, Ala	1,000
Mill Pond, Evergreen, Ala	2,000
Planters Factory Pond, Prattville, Ala	2,000
Cottrell Pond, Brantley, Ala	450
Tallapoosa River, Milstead, Ala	1,000
Mill Pond, Epes, Ala	1,000
Mill Pond, Franklin, Ala	1,000
Fish Pond, Louisville, Ala	290
Applicants in Alabama	2,825
Reservoir, Fairbank, Ariz	75
Verde River, Jerome, Ariz	75
Reservoir, Safford, Ariz	75
Silver Pond, Wilcox, Ariz	75
Upper Verde River, Prescott, Ariz	75
Applicants in Arizona	150
Fish Lake, Morrillton, Ark	400
Spring River, Hardy, Ark	400
Short Creek, Harrison, Ark	100
Spring River Lake, Mammoth Spring, Ark	400
Ouachita River, Malvern, Ark	150

Details of distribution—Continued.

Species and disposition.	Finger-lings, year-lings, and adults.
Black bass—Continued.	
Fish Pond, Malvern, Ark	100
Clear Creek, England Station, Ark	275
Fish Pond, Thornton, Ark	275
Clear Lake, Portia, Ark	150
Clear Creek, Fayetteville, Ark	1,000
Clear Creek, Meadows, Ark	1,000
Applicants in Arkansas	600
Lake Hollister, Windsor, Colo	100
Bass Lake, Elizabeth, Colo	75
Windsor Lake, Windsor, Colo	100
Lake Wauconda, Larkspur, Colo	75
Lake Logan, Canon City, Colo	75
Fish Lake, Sterling, Colo	200
Swanson Lake, Cimarron, Colo	150
Portland Lake, Colorado Springs, Colo	75
Lilly Lake, Lyons, Colo	100
Edgewater Lake, Denver, Colo	75
Lake Lindenmeier, Fort Collins, Colo	100
Applicants in Colorado	175
Cream Hill Lake, Lime Rock, Conn	150
Mudge Pond, Sharon, Conn	100
Beaver Dam Pond, Litchfield, Conn	150
Carp Pond, Newton, Conn	100
Aspinook Reservoir, Jewett City, Conn	200
Droups Reservoir, South Norwalk, Conn	150
State Fish Commission, Windsor Locks, Conn	950
Brandywine Creek, Wilmington, Del	300
Frazer Lake, Rehoboth, Del	100
Mill Pond, Turnerville, Ga	100
Flat Creek, Turnerville, Ga	100
Black Creek, Turnerville, Ga	500
Deep Creek, Turnerville, Ga	200
Tributary of Deep Creek, Turnerville, Ga	75
Potato Creek, Turnerville, Ga	75
Weaver Creek, Turnerville, Ga	75
Seals Pond, Marietta, Ga	45
Cartica Creek, Ellijay, Ga	62
Creek and Pond, Pecan, Ga	75
Spring Creek, Pecan, Ga	1,000
Lake Benson, Stinson, Ga	300
Whitewater Creek, Fayetteville, Ga	75
Rennetts Mill Pond, Fayetteville, Ga	200
Fish Pond, Utopia, Ga	300
Fish Pond, Williamson, Ga	2,000
Brooklyn Lake, Forsyth, Ga	100
Mill Pond, Sparta, Ga	200
Mill Pond, Wheelers Station, Ga	300
Carmichael Pond, Augusta, Ga	300
Jones Pond, Augusta, Ga	375
Mill Pond, Jonesboro, Ga	150
Fish Pond, Riverdale, Ga	100
Mill Pond, Senoia, Ga	200
Little Tallapoosa Creek, Carrollton, Ga	300
Mill Pond, Carrollton, Ga	200
Fish Lake, Atlanta, Ga	400
East Lake, Atlanta, Ga	1,300
Reservoir, Atlanta, Ga	400
Yellowstone Creek, Jackson, Ga	200
Middle Oconee River, Athens, Ga	2,000
Waterworks Lake, Athens, Ga	1,000
Fish Pond, Athens, Ga	1,000
East Lake, Decatur, Ga	200
Fish Lake, Decatur, Ga	1,000
Forest Pond, Conyers, Ga	100
Yellow River, Porterdale, Ga	675
Fish Pond, White Plains, Ga	500
Spring Branch, Summerville, Ga	500
Fish Lake, Summerville, Ga	1,000
Little South River, Comer, Ga	2,000
Bass Pond, Brooks Station, Ga	500
Black bass—Continued.	
Fish Pond, Butler, Ga	500
Brush Creek Lake, Five Forks, Ga	200
Aquinney Creek, Thomasville, Ga	1,200
McQuirter Pond, Sparta, Ga	500
McGhee Pond, Dalton, Ga	40
Fish Lake, Dalton, Ga	640
Spring Creek, Rome, Ga	575
Oostanaula River, Rome, Ga	150
Crawford Creek, Rome, Ga	700
Armuchee Creek, Rome, Ga	1,075
Fish Lake, Rome, Ga	500
Holland Lake, Rome, Ga	500
Hammond Pond, Rome, Ga	500
Wickerson Pond, Rome, Ga	500
Holtzendorff Pond, Rome, Ga	500
Echols Mill Pond, Rome, Ga	500
Mill Pond, Rome, Ga	1,050
Bass Lake, Dalton, Ga	80
Reservoir, Rossville, Ga	40
Chickamauga Lake, Chickamauga, Ga	80
Crawfish Spring Lake, Chickamauga, Ga	80
Cleghorn Pond, Summerville, Ga	40
Edmondson Pond, Summerville, Ga	40
Fish Lake, Summerville, Ga	40
Mill Pond, Summerville, Ga	40
Mill Pond, Cave Spring, Ga	100
Silver Lake, Chamblee, Ga	700
Beaver Dam Creek, Clarksville, Ga	75
Fish Pond, Milledgeville, Ga	1,000
Mill Pond, Winder, Ga	2,000
Suwanee Creek, Suwanee, Ga	500
Benton Pond, Turin, Ga	500
Augusta Pond, Augusta, Ga	2,000
Murray Hill Pond, Augusta, Ga	1,000
Beaver Creek, Reynolds, Ga	1,000
Wells Mill Pond, Smithville, Ga	900
Fish Pond, White Sulphur Springs, Ga	1,000
Mill Pond, Griffin, Ga	1,000
Long Branch, Clarksville, Ga	1,000
Vickers Lake, Willacoochee, Ga	1,000
Wartry Fish Pond, Willacoochee, Ga	500
Fish Lake, Tunnel Hill, Ga	500
Reservoir, Rossville, Ga	500
Poplar Spring, Cochran, Ga	1,000
Fish Pond, Tifton, Ga	500
Mill Pond, Newnan, Ga	1,500
Roberts Pond, Haddock, Ga	1,000
Bass Lake, Nicholson, Ga	1,000
Fish Pond, Eatonton, Ga	1,000
Flint River, Vaughn, Ga	1,000
Heads Creek, Vaughn, Ga	1,000
Bates Pond, Vaughn, Ga	1,000
Tallapoosa River, Buchanan, Ga	4,000
Kelly Pond, Cusseta, Ga	1,000
Spring Creek, Americus, Ga	1,000
McMurrain Pond, Upatoic, Ga	1,000
Artificial Lake, Rossville, Ga	2,000
Fish Pond, Genoa, Ga	1,000
Fish Pond, Cedartown, Ga	1,000
Yellow Rivers, Conyers, Ga	1,000
Riddley Pond, Lagrange, Ga	1,000
Outing Club Pond, Macon, Ga	1,000
Spring Creek Pond, Harrisburg, Ga	80
Spring Pond, Pomona, Ga	100
Applicants in Georgia	5,461
Rice Lake, Galesburg, Ill	4,805
Abbott Lake, Carlyle, Ill	200
Lily Lake Wheaton, Ill	150
Purate Pond, Belleville, Ill	100
Crescent Mill Pond, Belleville, Ill	100
Scott Lake Belleville, Ill	100
Twin Lakes, Twin Lakes, Ill	200
Mill Pond, Waverly, Ill	150
Canal, Ottawa, Ill	450
Park Lake Reservoir, Paris, Ill	525
Stone Creek, Blue Island, Ill	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Crystal Lake, Crystal Lake, Ill	200
McNair Pond, Clay City, Ill	100
Canagga Fish Pond, Effingham, Ill	200
Clover Leaf Lake, Donnellson, Ill	200
Fish Pond, Highland Park, Ill	100
Mill Pond, Freeburg, Ill	500
Freeburg Lake, Freeburg, Ill	350
Fish Pond, Millstadt, Ill	100
Burghardt Lake, Belleville, Ill	100
Lake Marie, Antioch, Ill	500
Fish Pond, New Athens, Ill	100
Swansea Lake, Belleville, Ill	100
Ahrens Lake, Columbia, Ill	200
Gilmore Lake, Columbia, Ill	300
Long Pond, Columbia, Ill	100
Spring Lake, Hillside, Ill	100
Deep and Cedar lakes, Lake Villa, Ill	250
Long Lake, Stallings, Ill	100
Fairview Lakes, Casey, Ill	225
Crystal Lakes, Litchfield, Ill	100
Lake Forest, Lake Forest, Ill	325
Round Lake, Waukegan, Ill	100
George Lake, Morris, Ill	225
Spring Lake, Streator, Ill	150
Shetland Lake, Monmouth, Ill	100
Spring Lake, Grays Lake, Ill	100
Fish Club Lake, Carterville, Ill	75
Zimmerman Lake, Carterville, Ill	75
Lake Peterson, Carterville, Ill	75
Hillside Pond, Millstadt, Ill	225
Eckert Long Pond, Millstadt, Ill	225
Johnson Lake, Millstadt, Ill	150
Arras Pond, Millstadt, Ill	150
Riley Rest Lake, Irving, Ill	120
Weldon Springs Lake, Clinton, Ill	300
Kelley Lake, Hallidayboro, Ill	138
Doyle Pond, Wrightsville, Ill	75
City Reservoir, Olney, Ill	750
Bluffside Fishing Club Lake, East St. Louis, Ill	225
C. & A. Reservoir, Tallula, Ill	225
Lake Spiller, Carbondale, Ill	150
Loon Lake, Lake Villa, Ill	225
Clement Lake, Danville, Ill	350
Spring Pond, Danville, Ill	225
Kickapoo Creek, Atlanta, Ill	250
Spring Pond, Carlinville, Ill	300
Henderson Lake, Virginia, Ill	100
Reservoir, Virginia, Ill	100
Spring Lake, Anna, Ill	225
Chautauqua Lake, Shelbyville, Ill	250
Parkhurst Lake, Fairfield, Ill	225
Waterworks Pond, Fairfield, Ill	225
Fish Pond, Fairfield, Ill	225
Sunnyside Lake, Coldbrook, Ill	150
Fox River, Aurora, Ill	415
Yorkville, Ill	315
Geneva, Ill	210
Palos Park Lake, Palos Park, Ill	150
Soldier's Home Reservoir, Quincy, Ill	295
Bass Lake, Bloomington, Ill	315
Quarry Pit, Chenoa, Ill	150
Du Page River, Plainfield, Ill	225
Fish Pond, McHenry, Ill	245
Rock River, Oregon, Ill	375
Yellow Creek, Freeport, Ill	150
Fish Pond, Freeport, Ill	225
Apple River, Elizabeth, Ill	300
Railroad Pond, Clapper, Ill	100
Petite Lake, Antioch, Ill	300
Antioch Lake, Antioch, Ill	225
Railroad Reservoir, Holland, Ill	200
Applicants in Illinois	10,481
Waterworks Pond, Batesville, Ind	[illegible]
Tippecanoe Lake, Leesburg, Ind	70
Winona Lake, Winona, Ind	70
Notre Dame Lake, South Bend, Ind	35

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Wolf and George lakes, Hammond, Ind	200
Fish Lake, Connersville, Ind	150
West Fork Whitewater River, Connersville, Ind	150
Lake Bass, Evansville, Ind	80
Forest Hill Cemetery Lake, Evansville, Ind	80
Kitzinger Lake, Evansville, Ind	80
Fair Grounds Pond, Chrisney, Ind	100
Lick Creek and Lost River, Paoli, Ind	600
Arnold Lake, Peabody, Ind	60
Wawasee Lake, Wawasee, Ind	45
Fourteen-mile Creek, Charlestown, Ind	100
Meryfield Lake, Mishawaka, Ind	35
Fish Pond, Cementville, Ind	75
Fish Pond, Crawfordsville, Ind	100
Sand Creek, Elizabethtown, Ind	150
Fish Pond, Bloomfield, Ind	200
Flint Lake, Valparaiso, Ind	350
Pigeon Creek, Boonville, Ind	600
Fish Lake, Lowell, Ind	250
Lake Everett, Fort Wayne, Ind	250
Brookville Canal, Brookville, Ind	150
Gravel Pit Fish Pond, Liberty Center, Ind	75
Driftwood Creek, Columbus, Ind	130
Wabash River, Bluffton, Ind	150
Gravel Pit, Bluffton, Ind	150
Sylvan Lakes, Rome City, Ind	100
Birch Lake, Gentryville, Ind	150
Kankakee River, Wilder, Ind	200
Richland Creek, Bloomfield, Ind	400
Reservoir, Wolcott, Ind	75
Kerbaugh Pond, Jamestown, Ind	100
Simmonton Lake, Elkhart, Ind	100
Mud Lake, Macy, Ind	150
Center Lake, Warsaw, Ind	50
Caldwell Lake, Claypool, Ind	150
Carr Lake, Claypool, Ind	150
Homan Lake, Claypool, Ind	150
Fish Pond, Greensburg, Ind	75
Fish Lake, Richmond, Ind	75
Fish Pond, Princeton, Ind	250
West Fork Whitewater River, Milton, Ind	150
Greensfork River, Milton, Ind	150
Fish Lake, New Albany, Ind	50
Wabash Lake, Vincennes, Ind	1,350
Lake Cicott, Logansport, Ind	400
Knowlands Fork, Milton, Ind	150
Simons Creek, Milton, Ind	150
Martindale Creek, Milton, Ind	150
Fancher Lake, Crown Point, Ind	150
Cedar Lake, Cedar Lake, Ind	200
Fall Creek, Malott Park, Ind	150
Juniper Lake, Miller, Ind	200
Grand Calumet River, Miller, Ind	550
Granger Slough, Miller, Ind	150
Long Lake, Miller, Ind	150
Willow Creek, Miller, Ind	100
Sylvan Lake, Rome City, Ind	100
Sand Creek, North Vernon, Ind	75
Newman Pond, Bristol, Ind	75
Reservoir, Jeffersonville, Ind	150
Cypress Creek, Boonville, Ind	600
Rocky Branch, Boonville, Ind	200
Fairview Spring Lake, Boonville, Ind	150
Downy Lake, Princeton, Ind	150
Richland Creek, Bloomfield, Ind	200
Plummer Creek, Bloomfield, Ind	600
Knob Creek, New Albany, Ind	75
Sugar Creek, Crawfordsville, Ind	300
Lake of the Wood, Bremen, Ind	45
Fish Lake, Seymour, Ind	75
Sanitarium Lake, Connersville, Ind	100

Details of distribution—Continued.

Species and disposition.	Finger-lings, year-lings, and adults.	Species and disposition.	Finger-lings, year-lings, and adults.
Black bass—Continued.		*Black bass*—Continued.	
Lake Maxinkuckee, Culver, Ind	400	Cheyenne Creek, Shields, Kans	125
Francisco Mill Pond, Princeton, Ind	100	Glencoe Lake, Vesper, Kans	100
Gravel Lake, Evansville, Ind	100	Reservoir, Oakley, Kans	75
Pretty Lake, Plymouth, Ind	85	Reservoir, Winona, Kans	75
Crew Lake, Vincennes, Ind	150	Hackberry Creek, Grainfield, Kans	250
Applicants in Indiana	4,259	Jeanette Lake, Soldiers' Home, Kans	350
Browns Pond, Ardmore, Ind. T	100	Bradford Lake, Wetmore, Kans	125
Mill Pond, Ardmore, Ind. T	100	Prairie Dog Creek, Jennings, Kans	250
Chickasaw Lake, Ardmore, Ind. T	150	Maguire Lake, Hutchinson, Kans	200
Club Pond, Ardmore, Ind. T	150	Johns Creek, Meade, Kans	150
Choctaw Lake, South McAlester, Ind. T	100	Mill Pond, Laharpe, Kans	100
Pennington Creek, Caddo, Ind. T	100	Cana River, Grenola, Kans	125
Fish Pond, Sallisaw, Ind. T	90	Little Arkansas River, Newton, Kans	500
Applicants in Indian Territory	775	Slate Creek, Newton, Kans	100
Fish Pond, Spiro, Ind. T	1,000	Spring Creek, Coldwater, Kans	100
Spring Branch, Leon, Iowa	125	Fish Lake, Medicine Lodge, Kans	150
Cedar River, Cedar Rapids, Iowa	150	Finnemore Lake, Buhler, Kans	225
Maquoketa River, Manchester, Iowa	350	Brooks Lake, Wellington, Kans	75
Lake Manza, Grinnell, Iowa	200	Buckner Creek, Dodge City, Kans	75
Volga River, Volga, Iowa	330	Pawnee River, Burdette, Kans	200
Lake Manawa, Council Bluffs, Iowa	500	Wallace Pond, Kingman, Kans	100
Crane Creek, Riceville, Iowa	200	Spring Brook, Kingman, Kans	100
Little Cedar River, New Hampton, Iowa	200	Lake Chromo, Olathe, Kans	300
Fish Lake, Winterset, Iowa	100	Mulberry Creek, Bucklin, Kans	150
Cedar River, Waterloo, Iowa	500	Doyle Creek, Peabody, Kans	150
Des Moines River, Humboldt, Iowa	200	Fall River, Fall River, Kans	100
Wapsipinicon River, Quasqueton, Iowa	350	Applicants in Kansas	4,600
Big Turkey River, Calmar, Iowa	200	Nolin River, Nolin, Ky	225
Mississippi River, Gordons Ferry, Iowa	800	Little River, Hopkinsville, Ky	80
Mississippi River, McGregor, Iowa	1,500	Fish Pond, Hopkinsville, Ky	120
Mississippi River, Clayton, Iowa	1,200	East Fork Little River, Hopkinsville, Ky	160
Applicants in Iowa	1,125	Fish Lake, Allensville, Ky	80
Beaver Creek, Leoti, Kans	250	Spring Pond, Powers, Ky	400
Republican River, Clay Center, Kans	200	Creegs Lake, Shelbyville, Ky	50
Brook Branch, Manhattan, Kans	125	Stoner Creek, Paris, Ky	150
Mill Creek, Manhattan, Kans	125	Elkhorn Creek, Elkhorn, Ky	150
Upper Deep Creek, Manhattan, Kans	150	Spring Lake, Paris, Ky	50
Conroy Lake, Manhattan, Kans	125	Houston Creek, Paris, Ky	50
Deep Creek, Manhattan, Kans	125	Laurel River, Corbin, Ky	105
Wild Cat Creek, Manhattan, Kans	125	Hanging Root Creek, Lancaster, Ky	100
Beach Creek, Manhattan, Kans	125	Anderson Lake, Newport, Ky	100
Semar Lake, Manhattan, Kans	100	Blacks Pond, Bagdad, Ky	25
Elbow Creek, Manhattan, Kans	125	Kinniconnick River, Vanceburg, Ky	675
Murdock Lake, Manhattan, Kans	100	Slate Creek, Mt. Sterling, Ky	50
Goodwin Creek, Manhattan, Kans	125	Dicks River, Rowland, Ky	100
McIntyre Creek, Manhattan, Kans	125	Fish Pond, Marion, Ky	200
Pfiel Creek, Manhattan, Kans	125	Redmon's Pond, Pine Grove, Ky	75
Seven Mile Creek, Manhattan, Kans	125	Cumberland River, Williamsburg, Ky	150
McDowell Creek, Manhattan, Kans	150	Green River, McKinney, Ky	200
Carnahan Creek, Manhattan, Kans	150	Licking River, Butler, Ky	150
Cedar Creek, Manhattan, Kans	150	Reservoir, Springfield, Ky	50
Ritten Creek, Manhattan, Kans	150	Spring Pond, Lynn, Ky	100
Fry Creek, Manhattan, Kans	150	Cold Springs Pond, Brent, Ky	75
Baldwin Creek, Manhattan, Kans	150	Graces Lagoon, Gracey, Ky	400
Clark Creek, Manhattan, Kans	150	Wood Lake, Elkhorn, Ky	50
Silver Creek, Manhattan, Kans	125	Stevensburg Lake, Stevensburg, Ky	100
Chapman Creek, Manhattan, Kans	150	Nolin Creek, Elizabethtown, Ky	100
Kaw River, Manhattan, Kans	125	Middle Creek, Elizabethtown Ky	100
Berry Pond, Manhattan, Kans	125	Valley Creek, Elizabethtown, Ky	100
Blue River, Manhattan, Kans	125	Duncan Lake, Lexington, Ky	50
Finnley Lake, Manhattan, Kans	100	Tile Works Lake, Louisville, Ky	150
Eureka Lake, Manhattan, Kans	125	Dudley Lake, Covington, Ky	100
Fish Lake, Manhattan, Kans	100	Railroad Lake, Parksville, Ky	120
Stone Lake, Leavenworth, Kans	100	Applicants in Kentucky	3,565
Mill Pond, Connor, Kans	125	Estelle Lake, Baton Rouge, La	125
Wakarusa Creek, Topeka, Kans	400	Lake Henrietta, Mansfield, La	75
Chickaskia River, Wellington, Kans	200	Spring Pond, Kentwood, La	150
Ninnesch River, Zyba, Kans	200	Livermans Pond, Mansfield, La	75
Big Blue River, Blue Rapids, Kans	400	Old River, Shreveport, La	100
Lake View, Lake View, Kans	375	Red Bayou, Gillian, La	100
Wakarusa Lake, Wakarusa, Kans	100	Bass Lake, Lane, La	100
Elm Creek, Miller, Kans	125	Hayes Lake, Reisor, La	100
		Lake Julia, Brevelle, La	100
		Bears Lake, Taylortown, La	100
		Lake Marie, Natchitoches, La	100

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Bass Lake, Robeline, La	75
Chaplin Lake, Natchitoches, La	100
Artificial Lake, Wisner, La	100
Applicants in Louisiana	600
Potomac River—	
Great Falls, Md	60,000
Seneca, Md	20,000
Woodmont, Md	1,675
Fish Pond, Cockeyville, Md	200
Oyster Creek, Annapolis, Md	200
Miles Creek, Easton, Md	150
Head of Black River, Rosedale, Md	100
Choptank River, Greensboro, Md	1,007
Bayside Lake, Baltimore, Md	100
Mill Creek, Snow Hill, Md	200
Israels Creek, Frederick, Md	200
Lingamore Creek, Frederick, Md	200
Monocacy River, Frederick, Md	200
Middle River, Baltimore County, Md	300
Western Run, Glyndon, Md	100
Rock Creek, Rockville, Md	100
Nottingham Creek, Chase Station, Md	100
Transquakin River, Cambridge, Md	800
Back Creek, Elkton, Md	400
Wimans Cove Pond, St. Denis, Md	200
Fish Pond, Baltimore, Md	200
Potomac River, Cumberland, Md	400
Fish Lake, Ridge, Md	100
Unicorn Pond, Millington, Md	125
Fish Pond, Monkton, Md	175
Fish Pond, Rossville, Md	200
Monocacy River—	
Motter, Md	1,000
Rocky Ridge, Md	1,000
St. Martins River, Bishop, Md	1,200
Fish Pond, Taneytown, Md	314
Wicomico River, Salisbury, Md	1,000
Bird River, Chase, Md	600
Whites Lake, Pocomoke City, Md	800
Applicants in Maryland	300
Abonsett Lake, Lynn, Mass	200
Bass Pond, Marblehead, Mass	150
Noquackoke Lake, Fall River, Mass	350
Moshers Pond, Fall River, Mass	100
Singletary Pond, Millbury, Mass	200
Long Pond, East Freetown, Mass	100
Onota Lake, Pittsfield, Mass	150
Connecticut River, Mount Tom, Mass	200
Fish Pond, Lynn, Mass	150
Cape Pond, Gloucester, Mass	200
Cranberry Pond, Charlton, Mass	200
Lakes Rolland and Gerald, Houghton, Mich	200
Fortune Lake, Crystal Falls, Mich	150
Lake Sixteen, Iron River, Mass	200
Big Bass and Whitefish lakes, Watersmeet, Mich	200
Bull Lake, Edwardsburg, Mich	35
Silver Lake, Traverse City, Mich	70
Stevenson Lake, Clare, Mich	100
Dewey Lake, Clare, Mich	100
Five Lakes, Clare, Mich	100
Buck Lake, North Adams, Mich	100
Hagley Lake, Galier, Mich	35
White Lake, Kalamazoo, Mich	50
Devil Lake, Addison Junction, Mich	70
Fisher Lake, Three Rivers, Mich	75
Corey Lake, Three Rivers, Mich	75
Bruce Lake, Marshall, Mich	70
Lyon Lake, Marshall, Mich	70
Pleasant Lake, Leslie, Mich	150
Clam Lakes, Cadillac, Mich	120
Big Blue Lake, Muskegon, Mich	500
Holland Lake, Sheridan, Mich	100
River Basin, Monroe, Mich	115
Black bass—Continued.	
Chain of Lakes, Central Lake, Mich	70
Fork Lake, Greenville, Mich	100
Stony Creek, Whittaker, Mich	300
Christmas Lake, Excelsior, Minn	500
Eagle Lake, Willmar, Minn	250
Lake Hendricks, Hendricks, Minn	500
Woman Lake, Hackensack, Minn	250
Serpent Lake, Deerwood, Minn	250
Lake Reno, Deerwood, Minn	200
Steel Lake, Cromwell, Minn	200
Lake Masaska, Faribault, Minn	200
Spring Branch, Shuqualak, Miss	100
Tuscumbia River, Corinth, Miss	90
Fish Lakes, Corinth, Miss	165
Morrisons Mill Pond, Corinth, Miss	60
Howard Lake, Macon, Miss	150
Fish Pond, Macon, Miss	100
Bass Lake, Macon, Miss	100
Hodges Pond, Macon, Miss	100
Big Bogue Chitto Creek, Macon Miss	300
Fish Lake, Macon, Miss	150
Spring Branch, Whynot, Miss	100
Wanita Lake, Meridian, Miss	200
Meador Lake, Winchester, Miss	250
Fish Pond, Bucatunna, Miss	250
Lake Chautauqua, Crystal Springs Miss	150
Lake Leonard, Hazelhurst, Miss	100
Lake Small, Hazelhurst, Miss	100
Tangipahoa River, Fernwood, Miss	250
Milk Pond, Magnolia, Miss	200
Spring Creek, Magnolia, Miss	100
Fish Lake, Magnolia, Miss	100
Spring Lake, Magnolia, Miss	100
Twin Lake, Vicksburg, Miss	550
Big Lake, Canton, Miss	150
Lake McBride, Canton, Miss	100
Bee Lake, Thornton, Miss	200
Wolf Lake, Yazoo City, Miss	400
Spring Branch, Hattiesburg, Miss	300
Tupelo Park, Tupelo Lake, Miss	280
Public Pond, Okolona, Miss	40
Fish Lake, Okolona, Miss	40
Mayhorn Lake, Starkville, Miss	60
Lake Alice Scobey, Miss	50
Fish Lake, Grenada, Miss	75
Quiver Creek, Pernell, Miss	80
Black Lake, McCool, Miss	100
Spring Lake, McCool, Miss	100
Yokonookony River, McCool, Miss	150
Cedar Lake, McCool, Miss	100
Pearl River, Ethel, Miss	250
Spring Lake, New Albany, Miss	150
Applicants in Mississippi	5,910
Silver Creek, Joplin, Mo	150
Hillrest Lake, Greenwood, Mo	100
Anthony Lake, Belt Junction, Mo	100
Flat Creek, Sedalia, Mo	300
Holmes Lake, Kansas City, Mo	100
Fish Pond, Kansas City, Mo	100
Elms Lake, Moundville, Mo	100
Lake Park Springs, Nevada, Mo	150
Fish Pond, Golden City, Mo	150
North Lake, Miller, Mo	100
Artificial Lake, Schell City, Mo	100
Spring Lake, Schell City, Mo	100
Railroad Reservoir, Willow Springs, Mo	150
Railroad Pond, Lockwood, Mo	150
Katy Allen Lake, Nevada, Mo	250
Hickory Creek, Neosho, Mo	1,450
Applicants in Missouri	453
Patrick Lake, Southbend, Nebr	500
Cut Off Lake, Omaha, Nebr	700
Fish Pond, Ogallala, Nebr	300
Spring Lake, Benkelman, Nebr	500
Applicants in Nebraska	350
Round Pond, South Merrimack, N. H	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Chocoma Lake, West Ossipee, N. H.	390
Muddy and Morris runs, Norma, N. J	100
Ewan Mill Pond, Ewan, N. J	150
Maurice River, Vineland, N. J	150
Lake Mashipacong, Port Jervis, N. J	400
Rancocas Creek, Mount Holly, N. J.	150
Spring Lake, Dundee, N. J	100
Knox Pond, Seabright, N. J	100
Eldora Pond, Eldora, N. J	100
Lake Vansant, Camden, N. J	150
Calley Lake, Springer, N. Mex	75
South Spring River, Roswell, N. Mex	100
Jaritas Lake, Springer, N. Mex	75
Hendrous Lake, Tucumcari, N. Mex	100
Fort Stanton Sanitarium Ponds, Capitan, N. Mex	100
Applicants in New Mexico	225
Fish Ponds, Hempstead, N. Y	400
Lake Nowidona, Water Mill, N. Y.	150
Green River Pond, East Hampton, N. Y	150
Nassau Pond, West Sand Lake N. Y.	300
Hybarts Creek, Fayetteville, N. C.	80
Beaver Lake, Fayetteville, N. C.	40
Texas Lake, Fayetteville, N. C	50
Bonnie Doon Lake, Fayetteville, N. C.	50
McPherson Lake, Fayetteville, N. C	40
Fish Lake, Fayetteville, N. C.	40
Goddard Lake, Fayetteville, N. C.	40
Mill Pond, Fayetteville, N. C.	50
Lumber River, Laurinsburg, N. C.	50
Catawba River, Morganton, N. C.	64
Cane River, Green Mountain, N. C.	200
Thompson Pond, Mount Airy, N. C.	50
Tar River, Louisburg, N. C	85
Sandy Creek, Louisburg, N. C	40
Long Creek Pond, Newbern, N. C.	85
Duck Pond, Morven, N. C	40
Lake Acton, Charlotte, N. C	43
Matrimony Creek, Leaksville, N. C.	40
Aberdeen Creek, Pine Bluff, N. C.	100
Mattamuskeet Lake, Fairfield, N. C.	200
Mill Pond, Raleigh, N. C	50
Hinton Lake, Raleigh, N. C	50
Fish Lake, Raleigh, N. C	50
Fish Pond, Raleigh, N. C	50
Old Tyber Mill Pond, Kelford, N. C.	50
Spray Lake, Spray, N. C	40
Mill Pond, Hickory, N. C	32
Deep Creek, Crutchfield, N. C	40
Fish Pond, Oxford, N. C	50
Fish Pond, Lenoir, N. C	32
Freestone Pond, Wilkesboro, N. C.	25
Duncraggan Lake, Hendersonville, N. C	50
Fishing Club Pond, Hendersonville, N. C	200
Tributaries of Pamlico River, Washington, N. C	85
Anderson Pond, Pine Hall, N. C.	25
Lake Waccamaw, N. C	85
Mill Pond, Clarkton, N. C	50
Spring Branch, Springhope, N. C.	40
Mill Pond, Morganton, N. C	32
Shiloh Mill Pond, Tarboro, N. C.	160
Harrington Pond, Rockingham, N. C	85
Fish Pond, Goldsboro, N. C	200
Catawba River, Marion, N. C	95
French Broad River, Asheville, N. C.	50
Cane River, Cane River, N. C	50
Racine Pond, Gastonia, N. C	15
Applicants in North Carolina	931
Long Lake, Pleasant Lake, N. Dak.	100
Black bass—Continued.	
Indian and Rose lakes, Rolla, N. Dak	300
Crooked Creek, Dickinson, N. Dak.	500
Highland Park Lake, Cincinnati, Ohio	200
Parrot Pond, Sardinia, Ohio	75
Whitewater River, Harrison, Ohio.	400
Grand River, West Farmington, Ohio	150
Waterworks Reservoir, Geneva, Ohio	100
Taylor Pond, Cambridge, Ohio	25
Licking River, Claypool, Ohio	213
Twin Lakes, Earlville, Ohio	37
Chippewa Lake, Chippewa Lake, Ohio	50
Spring Lake, Coalton, Ohio	100
Twin Lake, Kent, Ohio	100
Cuyahoga River, Kent, Ohio	100
Big Miami River, Piqua, Ohio	150
Stillwater Creek, Pleasant Hill, Ohio	140
Sandy and Beaver Canal, Kensington, Ohio	50
Bass Lake, Chardon, Ohio	150
Chagrin River, Willoughby, Ohio	125
Maumee River—	
Waterville, Ohio	115
Defiance, Ohio	200
Antwerp, Ohio	150
Napoleon, Ohio	125
Chester Park Lake, Winton Place, Ohio	200
Stillwater River, Pleasanthill, Ohio	200
Geauga Lake, Geauga, Ohio	150
Spencer Reservoir, Barnesville, Ohio	50
Woods and Lincoln Park Lake, Cincinnati, Ohio	100
Cliff Lakes, Springfield, Ohio	100
Applicants in Ohio	1,150
Trail Creek, Weatherford, Okla	100
Willow Creek, Fort Cobb, Okla	100
Avery Lake, Guthrie, Okla	300
Youst Reservoir, Guthrie, Okla	350
Forest Lake, Purcell, Okla	250
Spring Branch, Cleo, Okla	100
Fish Lake, Lawton, Okla	100
Spring Branch, Mulhall, Okla	150
North Canadian River, Oklahoma City, Okla	150
Fish Pond, Higgins, Okla	150
Fish Pond, Purcell, Okla	100
Headwaters of Cache Creek, Caddo Co., Okla	150
Fish Pond, Lawton, Okla	175
Fish Lake, Cleo, Okla	100
Cottonwood Creek, Elk City, Okla.	250
Salt Lake, Red River, Okla	200
Reservoir, Beaver County, Okla	100
Spring Creek, Renfrow, Okla	100
Applicants in Oklahoma	900
Neshaming Creek, Newton, Pa	150
Marsh Creek, Gettysburg, Pa	850
Little Swatara Creek, Lebanon, Pa.	450
Conestoga Creek, Lancaster, Pa	100
Schuylkill River, Birdsboro, Pa	200
French Creek, Pottstown, Pa	200
Mountain Creek, Mount Holly Springs, Pa	200
Maiden Creek, Lenhartsville, Pa.	200
Lehigh River, Freemansburg, Pa.	300
Brandywine Creek, Downington, Pa	350
Marsh Creek, Fairfield, Pa	200
Fish Lake, Pottsville, Pa	100
Bear Lake, Wilkesbarre, Pa	200
North Branch Susquehanna River, Catawissa, Pa	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Sandy Bottom Creek, Frackville, Pa	150
Cajaw Pond, Honesdale, Pa	350
Mill Pond, East Mahanoy Junction, Pa	150
Fish Pond, Clifford, Pa	200
Little Elk Lake, Montrose, Pa	150
Forest Lake, Montrose, Pa	200
Big Elk Lake, Montrose, Pa	400
Deer Lake, Bushkill, Pa	100
Coxtown Fish Pond, Winwood, Pa	150
Wrighter and Dunn lakes, Thompson, Pa	150
Susquehanna River, Susquehanna, Pa	400
Quaker Lake, Susquehanna County, Pa	150
Yellow Breeches Creek, Carlisle, Pa	300
Oswego Creek, Shinglehouse, Pa	200
Allegheny River—	
Thompson, Pa	400
Kinzua, Pa	300
Susquehanna River, Lock Haven, Pa	200
Wells Creek, Hyndman, Pa	200
Raystown Branch Juniata River—	
Hopewell, Pa	350
Riddlesburg, Pa	150
Huntingdon, Pa	950
Juniata River, Huntingdon, Pa	400
Standing Stone Creek, Huntingdon, Pa	300
Crooked Creek, McConnellstown, Pa	100
Black Lick Creek, Indiana, Pa	150
Beaver Run Reservoir, West Apollo, Pa	150
Clarion River, Foxburg, Pa	200
Conneaut Lake, Conneaut Lake, Pa	150
Pymaturning Creek, Orangeville, Pa	200
Lost Creek, Mifflin, Pa	150
Otter Creek, Fredonia, Pa	325
Frankstown Branch Juniata River, Alexandria, Pa	150
Juniata River, Alexandria, Pa	250
Brandywine Creek, Westchester, Pa	105
Keeny Lake, New Freedom, Pa	60
Gunpowder Lake, New Freedom, Pa	30
Lanzon Lake, Kelton, Pa	50
Ridley Park Lake, Ridley Park, Pa	30
Fish Pond, Westchester, Pa	30
Sheppard Pond, Providence, R. I	100
Hospital Pond, Providence, R. I	100
Vennen Pond, Providence, R. I	100
Mashapang Lake, Providence, R. I	100
Randall Pond, Providence, R. I	100
Tucker Pond, Kingston, R. I	500
Beaver Dam Pond, Hartville, S. C	100
Middle Saluda River, Greenville, S. C	75
North Saluda River, Greenville, S. C	100
Saluda River, Greenville, S. C	100
Mountain Creek, Greenville, S. C	100
Reedy River, Greenville, S. C	50
Tucapan Mill Pond, Wellford, S. C	250
Pond and stream, Spartanburg, S. C	75
Enoree River, Fountain Inn, S. C	100
Spring Pond, Clover, S. C	65
Chick Spring Lake, Taylors, S. C	50
Mill Pond, Sanford, S. C	100
Fish Pond, Barr, S. C	50
Twelve-mile Creek, Barr, S. C	100
Fish Pond, Trenton, S. C	50
Catawba River, Rock Hill, S. C	100
Fish Pond, Fairfax, S. C	175
Mill Pond, Greenville, S. C	50

Species and disposition	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Cane Creek, Lancaster, S. C	125
Gills Creek, Lancaster, S. C	75
Waxham Creek, Lancaster, S. C	50
Fish Pond, Sumter, S. C	50
Fish Pond, Mullins, S. C	100
Rose Hill Mill Pond, Sumter, S. C	75
Beaver Lake, Aiken, S. C	50
Big Stevens Creek, Plumbranch, S. C	150
Applicants in South Carolina	250
Lake Dewey, Earling, S. Dak	150
Lake Kampeska, Watertown, S. Dak	700
Nixon Creek, Faulkton, S. Dak	150
Platte Creek, Platte, S. Dak	150
Turkey Creek, Volin, S. Dak	200
Silver Creek, Forestburg, S. Dak	250
James River, Forestburg, S. Dak	250
James River, Huron, S. Dak	300
Lake Byron, Huron, S. Dak	600
Wilcox Lake, Huron, S. Dak	150
Pearl and Shoe creeks, Huron, S. Dak	300
Reed Lake, Wessington, S. Dak	150
Turtle Creek, Ree Heights, S. Dak	150
Fish Pond, Highmore, S. Dak	200
Fish Pond, Eagle, S. Dak	200
Applicants in South Dakota	1,600
Poor Valley Creek, Whitesburg, Tenn	57
Waterville Pond, Cleveland, Tenn	50
Spring Lake, Cleveland, Tenn	50
Craigmiller Lake, Cleveland, Tenn	50
Horse Creek, Greenville, Tenn	200
Chickamauga Lake, Chattanooga, Tenn	500
McCallie Lake, Chattanooga, Tenn	60
Electric Lake, Chattanooga, Tenn	80
Spring Lake, Chattanooga, Tenn	40
Devines Lake, Chattanooga, Tenn	40
Willow Lake, Chattanooga, Tenn	40
Bonny Oaks Pond, Chattanooga, Tenn	80
Big Pigeon River, Newport, Tenn	200
French Broad River, Del Rio, Tenn	189
Wilson Pond, Springfield, Tenn	80
Fish Pond, Nashville, Tenn	240
Red River, Clarksville, Tenn	320
Buffalo River, Waverly, Tenn	240
Stack Spring Lake, Cumberland Furnace, Tenn	78
Swan Creek, Centerville, Tenn	156
Piney Creek, Nunnelly, Tenn	156
Duck River, Columbia, Tenn	200
Elk River, Fayetteville, Tenn	450
Flint River, Fayetteville, Tenn	600
Hobbs Pond, Fayetteville, Tenn	150
Holston River, Rogersville, Tenn	200
Tennessee River, Rogersville, Tenn	200
Tennessee River, London, Tenn	100
Tellico River, Athens, Tenn	50
Sweetwater Creek, Knoxville, Tenn	50
Fish Pond, Gallatin, Tenn	100
Piney River, Spring City, Tenn	100
Fish Lake, Knoxville, Tenn	100
Hiwassee River, Appalachia, Tenn	350
Applicants in Tennessee	598
Fish Lake, San Antonio, Tex	500
Country Club Lake, Bonham, Tex	225
Harris Lake, Hubbard, Tex	200
Alston Pond, Marquez, Tex	75
Braun Lake, Moore, Tex	150
Clear Creek, Canadian, Tex	300
Robbers Roost Creek, Canadian, Tex	200
Stanmise Lake, Oakwoods, Tex	500
Calloway Lake, Marshall, Tex	200
Highland Lake, Marshall, Tex	800
Fish Lake, Palestine, Tex	200
Railroad Tank, Coleman Junction, Tex	150

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Crist Fish Pond, Groesbeck, Tex	100
Rogers Pond, Hubbard, Tex	100
Artificial Lake, Palestine, Tex	200
Fish Lake Bellevue, Tex	200
Orphans' Home Lake, Corsicana, Tex	500
Lake Thorne, Longview, Tex	300
Artificial Lake, Richland, Tex	300
Lake O'Connell, Waco, Tex	125
Castleman Creek, Waco, Tex	1,000
Fish Lake, Waco, Tex	125
Lake Woodward, Waco, Tex	300
Spring Branch, Gilmer, Tex	150
Sulphur Fork Lampasas River, Lampasas, Tex	1,000
Elm Lake, Stephensville, Tex	200
Paladora Creek, Guyman, Tex	1,000
Brinker Lake, Sulphur Springs, Tex	400
Lake Como, Fort Worth, Tex	1,000
Fish Pond, Alice, Tex	300
Pool, Wolf City, Tex	25
Willow Springs Lake, Taylor, Tex	200
Bohls Lake, Taylor, Tex	100
Bass Lake, Taylor, Tex	300
Waterworks Pond, Taylor, Tex	200
San Pedro Springs, Encinal, Tex	150
Bass Pond, Laredo, Tex	500
Fielding Fish Pond, Petty, Tex	150
Fish Lake, Chillicothe, Tex	500
Wilbarger Creek, Littig, Tex	100
Fish Pond, Sadler, Tex	200
Johnson Lake, Paris, Tex	100
Gordon Lake, Paris, Tex	1,000
Oak Lake, Mesquite, Tex	200
White Oak Creek, Sulphur Springs, Tex	250
Rosebud Lake, Rosebud, Tex	200
Allen Creek, Clarendon, Tex	300
Freestone Pond, Arlington, Tex	75
Kelly Creek, Clarendon, Tex	200
Carroll Creek, Clarendon, Tex	200
Richardson Creek, Clarendon, Tex	200
Railroad Reservoir, New Boston, Tex	300
Spring Creek, Kosse, Tex	150
Fish Pond, Corsicana, Tex	600
Branch Lake, Weatherford, Tex	150
Jumbo Tank, Weatherford, Tex	40
Palestine Waterworks, Palestine, Tex	500
Harris Lake, Palestine, Tex	500
Clear Water Lake, Vernon, Tex	500
Wathalls Lake, Memphis, Tex	200
Mill Pond, Elkhart, Tex	200
Turkey Creek, Canadian, Tex	1,300
West End Lake, San Antonio, Tex	1,075
Elbow Lake, Clarksville, Tex	50
Fish Pond, Cameron, Tex	300
Club Lake, Honey Grove, Tex	500
Sherrell Springs Lake, Honey Grove, Tex	200
Hatfield Creek, Dallas, Tex	75
Trinity Club Lake, Dallas, Tex	1,575
Portland Lake, Dallas, Tex	125
Artificial Lake, Dallas, Tex	50
Koon Kreek Klub Lake, Athens, Tex	2,000
Fish Pond, Athens, Tex	500
Strand Creek, Granbury, Tex	300
City Reservoir, Stephensville, Tex	25
Paluxy Creek, Bluffdale, Tex	500
Bass Lake, Kerens, Tex	1,000
Fish Lakes, Brownwood, Tex	500
Tabor Lake, Brownwood, Tex	800
Artificial Reservoir, Brownwood, Tex	150
Cravens Lake, Arlington, Tex	100
Alfred Lake, Venus, Tex	100
Llano River, Llano, Tex	4,250

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Bass Lake, Sulphur Springs, Tex	250
Mill Pond, Sulphur Springs, Tex	200
Mill Pond, Commerce, Tex	95
Waterworks Pond, Mount Calm, Tex	200
Pool, Blossom, Tex	175
Fish Pond, Waskom, Tex	150
Cantonment Creek, Miami, Tex	1,000
Cypress Creek, Marble Falls, Tex	200
Park Lake, Tyler, Tex	500
Tank Lake, Alice, Tex	150
Santa Rosa Lake, Alice, Tex	575
Van Hook Pond, Marshall, Tex	150
Reservoir, Beeville, Tex	100
Como Pond, Hughes Springs, Tex	400
Irrigation Canal, Lane City, Tex	1,000
Silver Lake, Arlington, Tex	1,000
Cain Pond, Arlington, Tex	100
Holts Lake, West, Tex	100
McLennen Lake, West, Tex	500
Lake Sand Hill, Jonesville, Tex	200
Fish Pond, Kaufman, Tex	300
City Lake, Kaufman, Tex	1,200
Gunter Lake, Gunter, Tex	1,100
Fish Lake, Bonham, Tex	400
Bass Lake, Bonham, Tex	300
Country Club Lake, Bonham, Tex	625
Cotton Mill Oil Pool, Annona, Tex	400
Onion Creek Lake, Manchaca, Tex	150
Bear Creek, Manchaca, Tex	150
Artificial Lake, Clarksville, Tex	150
Fish Lake, Corsicana, Tex	1,000
Club Lake, Corsicana, Tex	500
Foster Lake, Crockett, Tex	100
Davey Crockett Pond, Crockett, Tex	200
Dickinson Bayou, Alvin, Tex	100
Crescent Lake, Overton, Tex	30
Fish Lake, Hubbard, Tex	300
Artificial Lake, Seymour, Tex	100
Allen Lake, Weimar, Tex	200
Lampasas River, Lampasas, Tex	2,000
Lake Kemp, Wichita Falls, Tex	2,000
Irrigation Pond, Wichita Falls, Tex	300
Mackenzie Lake, San Antonio, Tex	1,000
Fish Pond, Carmona, Tex	300
Pool, Santa Anna, Tex	50
Railroad Pond, Bryan, Tex	160
Wheatley Pool, Campbell, Tex	50
Spring Park Lake, Palestine, Tex	130
Railroad Lake, Childress, Tex	2,090
Railroad Lake, Gunter, Tex	90
Cypress Pond, Haywood, Tex	300
Polo Ranch Tank, San Antonio, Tex	100
Mill Pond, Lovelady, Tex	200
Clear Fork of Trinity River, Fort Worth, Tex	5,000
Hust Lake, Fort Worth, Tex	500
Fish Lake, Fort Worth, Tex	500
F. and B. Club's Lake, Waxahatchie, Tex	200
Fish Pond, Mexia, Tex	275
Private Lake, Brownwood, Tex	100
Brownwood Lake, Brownwood, Tex	175
Mesquite Ranche Lake, Brownwood, Tex	200
Fish Pond, Cuero, Tex	150
Germany Pond, Grand Saline, Tex	300
Berrie Pond, Woodville, Tex	300
Martins Tank, Lott, Tex	100
Ben Brook Lake, Lott, Tex	300
Fish Lake, Saron, Tex	300
San Antonio River, San Antonio, Tex	2,000
Tappin Lake, San Antonio, Tex	50
McKinsey Lake, San Antonio, Tex	75
Vance Lake, San Antonio, Tex	25
Lake View Lake, San Antonio, Tex	500
Reservoir, Greenville, Tex	300
Harris Lake, Handley, Tex	500

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Private Lake, Paris, Tex	150
San Gabriel River, Georgetown, Tex	1,000
Hoards Creek, Coleman, Tex	200
Home Creek, Coleman, Tex	200
Private Lake, Coleman, Tex	50
Elm Creek, Coleman, Tex	200
Panther Creek, Coleman, Tex	200
Mill Pond, Austin, Tex	400
Hackberry Tank, Clarendon, Tex	75
Wood Lake, Sherman, Tex	200
Private Lake, Sherman, Tex	100
Spring Lake, Hempstead, Tex	200
Flag Lake, Thornton, Tex	150
Cannon Tank, Thornton, Tex	100
Reservoir, Beaumont, Tex	150
Fish Pond, Beaumont, Tex	500
Artificial Lake, Corsicana, Tex	300
Cibolo River, Marion, Tex	1,000
Fish Lake, Grand Saline, Tex	125
Meserve Lake, Cameron, Tex	200
Redwater Pond, Redwater, Tex	1,000
Lake Katrina, Marshall, Tex	200
Lake Longinatti, Marshall, Tex	200
Lake Kinall, Dallas, Tex	300
Private Lake, Schulenburg, Tex	500
Four Fish Tanks, Lott, Tex	100
Fish Lake, Gilmer, Tex	125
Mill Creek, Bellville, Tex	1,000
Aldridge Pond, Plano, Tex	100
Bartons Tank, Terrell, Tex	100
Artificial Lake, Terrell, Tex	300
Cartwright Pond, Terrell, Tex	500
Fish Pond, Terrell, Tex	250
Fish Pond, Mount Pleasant, Tex	150
Fish Lake, Sulphur Springs, Tex	300
Railroad Lake, Bellevue, Tex	2,000
Railroad Lake, Phelps, Tex	2,000
Railroad Lake, Sadler, Tex	625
Fish Pond, Tyler, Tex	200
Railroad Tank, Elgin, Tex	400
Wetches River, Beaumont, Tex	2,750
Railroad Lake, Wichita Falls, Tex	1,000
Fish Ponds, Seymour, Tex	175
Railroad Lake—	
Celeste, Tex	250
Marlin, Tex	600
Mart, Tex	1,350
Fort Worth, Tex	1,450
Lake Polk, Temple, Tex	950
Applicants in Texas	7,265
Lake Eden, Eden Mills, Vt	200
Kenny Pond, Newfane, Vt	150
Derby Pond, Newport, Vt	450
Warden Pond, East Barnett, Vt	200
Big Pond, Woodford, Vt	150
Wolcott Pond, Wolcott, Vt	150
Lake Bomoseem, Castleton, Vt	200
Sadawga Lake, Whittingham, Vt	300
Bean Pond, Lyndonville, Vt	150
Rapidan River—	
Orange, Va	200
Rapidan, Va	200
Epperly Pond, Christiansburg, Va	150
Jackson River—	
Hot Springs, Va	150
Clifton Forge, Va	200
Silver Lake, Dublin, Va	100
Louis Creek, Blacksburg, Va	150
Tye River, Arrington, Va	200
James River—	
Lynchburg, Va	200
Gilmore Mills, Va	1,200
Thomas Creek, Prices Fork, Va	100
Pike Pond, Clifton Forge, Va	1,000
Fish Lake, Providence Forge, Va	150
Hazel River, Culpeper, Va	1,000
Reservoir, Harrisonburg, Va	100
Bowman Lake, Harrisonburg, Va	100
Stony Creek, Edenburg, Va	150
Black bass—Continued.	
Cedar Creek, Capon Pond, Va	200
Hogue and Rock creeks, Winchester, Va	200
Kenilworth Pond, Stephenson, Va	100
Guest River, Norton, Va	275
Fish Ponds, Winston, Va	600
Nottoway River, Courtland, Va	500
Strawberry Hill Lake, Strawberry Hill, Va	400
Mill Pond, Doswell, Va	812
Mill Pond, Caster, Va	100
New River, Grayson, Va	150
Fish Lake, Duffield, Va	75
Appomattox River, Prospect, Va	1,200
Mill Pond, Gloucester, Va	87
Mill Pond, Cedar Forest, Va	150
Lodge Pond, Mattox, Va	100
Club Pond, Cohoke, Va	150
Winfrees Mill Pond, Clayville, Va	100
Wolf Creek, Abington, Va	150
Lake of the Woods, Glen Allen, Va	200
Fish Pond, Houston, Va	300
Fish Pond, Meherrin, Va	200
Offley Mill Pond, Hewlett, Va	200
Little River, Verdon, Va	200
Mill Ponds, Petersburg, Va	375
Mill Pond, Hewlett, Va	100
Mill Pond, Lester Manor, Va	150
Mill Pond, Buffalo Lithia Springs, Va	150
Haris Pond, Clayvile, Va	100
Jones Pond, Clayville, Va	100
Fish Pond, Potomac Mills, Va	150
Woodwards Mill Pond, Powhatan, Va	100
Nicholls Pond, Powhatan, Va	100
Young Pond, Richmond, Va	150
Gregory Pond, Richmond, Va	200
West Hampton Park Lake, Richmond, Va	700
Edgemere Lake, Richmond, Va	500
Dan River, Danville, Va	1,800
Hanson Pond, Petersburg, Va	100
Brander Pond, Petersburg, Va	100
Swift Creek, Petersburg, Va	100
West End Lake, Petersburg, Va	500
Goose Creek, Leesburg, Va	25
Pond and stream, Grady, Va	250
Mill Pond, Bagleys Mills, Va	150
North Fork of Holston River, Rural Retreat, Va	150
Piney Creek Mill Pond, Clover, Va	150
Rappahannock River, Fredericksburg, Va	400
Mill Pond, Oak Grove, Va	50
Fish Pond, Somerset Station, Va	250
Spring Creek, Wingina, Va	400
Potomac River, Herndon, Va	25
Rappahannock River, Mineral, Va	150
Pamunkey River, Hanover, Va	100
Bascobal Pond, Fredericksburg, Va	168
Stock Farm Pond, Culpeper, Va	400
Mill Pond, Burkeville, Va	100
Goose Creek, Plains, Va	300
Thomas Creek, Vicker, Va	1,000
Lake Drummond, Wallaceton, Va	200
Evergreen Pond, Evergreen, Va	75
Smith River, Ridgway, Va	85
Fish Pond, Montross, Va	100
Wilson Creek, Christiansburg, Va	1,000
North Branch Shenandoah River, Buckton, Va	500
Katocton Run, Round Hill, Va	1,000
Anderson and Jones Ponds, Martinsville, Va	1,000
Hobbs Mill Pond, Crewe, Va	150
Fish Ponds, Boyce, Va	300
Burger River, Farmville, Va	300
Southana River, Maidens, Va	800
Catawba Creek, Troutville, Va	1,000

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Fish Pond, Bedford City, Va	300
Spring Pond, Lynch Station, Va	1,000
New River, Fries, Va	10,000
Thomas Fish Pond, Smithfield, Va	400
Tarrers Pond, Orange, Va	500
Hatcher Lake, Whitehall, Va	500
Holmans Creek, Quicksburg, Va	500
Fish Pond, Meltons, Va	400
Linville Creek Lake, Harrisonburg, Va	500
North River, Harrisonburg, Va	2,500
Nottaway River, Blackstone, Va	1,000
Silker and Cogbell Lake, Centralia, Va	400
Linville Creek, Broadway, Va	500
North Fork Shenandoah River, Broadway, Va	500
Rivanna Creek, Proffit, Va	600
Three Creeks, Emporia, Va	1,000
Spring Pond, Bedford City, Va	300
Applicants in Virginia	1,805
Fish Pond, Newport, Wash	200
Bluestone River, Bluefield, W. Va	200
Ohio River, Wellsburg, W. Va	400
Spring Run, Martinsburg, W. Va	300
Shenandoah River, Charlestown, W. Va	300
Fish Pond, Parkersburg, W. Va	200
Tygart Valley River—	
Elkins, W. Va	200
Valley Falls, W. Va	100
Nuzurn, W. Va	200
Elk River, Addison, W. Va	200
Monongahela River, Fairmont, W. Va	100
Cheat River, Morgantown, W. Va	200
Allegheny Run, Collins, W. Va	200
Second Creek, Ronceverte, W. Va	200
Baker Lake, Spooner, Wis	300
Spider Lake, Hayward, Wis	250
Diamond and Crystal lakes, Drummond, Wis	500
Elbow, Newton, and Lily lakes, Athelstane, Wis	500
Cedar Lake, West Bend, Wis	300
Long Lake, Brillion, Wis	200
Mississippi River, Glen Haven, Wis	500
Private Ponds, Sheridan, Wyo	500
Fish Pond, Sheridan, Wyo	200
Total	528,365
Crappie:	
Pettus Lake, Eutaw, Ala	100
Applicant at Marion, Ala	100
Sycamore Creek, Jerome, Ariz	75
Verde River, Jerome, Ariz	75
Pecks Lake, Jerome, Ariz	75
Applicant at Safford, Ariz	75
Reservoir No. 1, Rocky Ford, Colo	75
Minnequa Lake, Pueblo, Colo	75
Fish Pond, Hooper, Colo	75
Swan Pond, Seymour, Conn	500
Cheney Pond, Rome, Ga	200
Holland Pond, Rome, Ga	200
Artificial Pond, Toccoa, Ga	200
Local Pond, Tate, Ga	400
Fish Pond, Tate, Ga	400
Applicant in Georgia	150
Davis Pond, Macon, Ill	125
Tributary Kaskaskia River, Kirksville, Ill	250
Reservoir, Paris, Ill	250
Electric Light Pond, Carterville, Ill	350
Fish Pond, Carterville, Ill	350
Bluffside Fish Club's Lake, East St. Louis, Ill	700
Fish Pond, Columbia, Ill	300
Burghardt Lake, Belleville, Ill	350
Crappie—Continued.	
Crystal Lake, Crystal Lake, Ill	350
Canaggee Lake, Effingham, Ill	250
Fish Ponds, Millstadt, Ill	600
Soldier's Home Lake, Danville, Ill	3,500
Salt Creek and Kickapoo River, Lincoln, Ill	1,000
C. & A. Reservoir, Carlinville, Ill	500
Waterworks Pond, Mattoon, Ill	125
Fish Pond, Greenfield, Ill	300
Mississippi River, Savanna, Ill	30,000
Applicants in Illinois	625
West Fork Whitewater River, Connersville, Ind	200
Coal Creek, Veedersburg, Ind	300
Pine Creek, Williamsport, Ind	200
Spencer Pond, Lebanon, Ind	100
Arnolds Lake, Peabody, Ind	185
Muscatatuck River, North Vernon, Ind	200
Round Lake, Fort Wayne, Ind	200
Cedar Lake, Cedar Lake, Ind	200
Fish Lake, Muncie, Ind	200
Simonton Pond, Elkhart, Ind	200
Hunters Valley Quarry, Bloomington, Ind	150
Sugar Creek, Crawfordsville, Ind	200
Fish Pond, Bloomington, Ind	150
Chickasaw Lake, Ardmore, Ind. T	300
Fish Pond, Ardmore, Ind. T	200
Cedar River, Cedar Rapids, Iowa	1,925
Maquoketa River, Manchester, Iowa	2,200
Volga River, Volga, Iowa	3,385
Wapsipinicon River, Quasqueton, Iowa	3,400
Mississippi River—	
Bellevue, Iowa	90,000
Gordon Ferry, Iowa	105,000
Lanesville, Iowa	15,000
McGregor, Iowa	45,000
Clayton, Iowa	40,000
Stones Lake, Leavenworth, Kans	100
Cedar Lake, Manhattan, Kans	100
Jeanette Lake, Soldiers' Home, Kans	200
Chenaute Lake, Olathe, Kans	150
Cana River, Grenola, Kans	75
Fish Pond, Ottawa, Kans	100
Fish Pond, Edgarton, Kans	200
Fish Pond, Erie, Kans	75
Bourne Pond, Lancaster, Ky	50
Rolling Fork Creek, Lebanon, Ky	500
Jones Spring, Louisa, Ky	150
Tributary Big Sandy River, Louisa, Ky	250
Martins Pond, Frankfort, Ky	50
Elkhorn Creek, Frankfort, Ky	100
Fair Ground Pond, Springfield, Ky	200
Waterworks Reservoir, Springfield, Ky	200
Fish Pond, Owensboro, Ky	300
Kentucky River, Beattyville, Ky	200
Spring Lake, Powers, Ky	300
Stoner Creek, Paris, Ky	100
Owens Pond, Veechdale, Ky	50
Spring Lake, Pewee Valley, Ky	100
Kinniconnick River, Vanceburg, Ky	500
Lake View, Lexington, Ky	200
East Fork Little River, Hopkinsville, Ky	400
Reservoir, Springfield, Ky	100
Silver Lake, Frankfort, Ky	100
Nolin Creek, Elizabethtown, Ky	150
Old Reservoir, Louisville, Ky	300
Dowling Pond, Lawrenceburg, Ky	100
Fish Pond, Guthrie, Ky	150
Green River, Greensburg, Ky	600
Applicants in Kentucky	1,690
Oyster Creek, Annapolis, Md	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Crappie—Continued.	
Onota Lake, Pittsfield, Mass	500
Spring Lake, Spring Lake, Mich	200
Bull Lake, Edwardsburg, Mich	100
River Basin, Monroe, Mich	150
Eagle Lake, Edwardsburg, Mich	300
Tchell Lake, Proctor, Minn	400
Lake Como, Iuka, Miss	200
Wolf Lake, Yazoo City, Miss	110
Fish Lake, Corinth, Miss	200
Public Pond, Okolona, Miss	100
Fish Lake, Okolona, Miss	100
Fish Lake, Grenada, Miss	200
Rose Lake, Oxford, Miss	200
Quiver Creek, Pernell, Miss	184
Pearl River, Ethel, Miss	368
Applicants in Mississippi	534
Silver Creek, Joplin, Mo	100
Anthony Lake, Belt Junction, Mo	150
Holmes Lake, Kansas City, Mo	100
Fish Pond, Kansas City, Mo	100
Greenwood Lake, Greenwood, Mo	100
Lake Park Springs, Nevada, Mo	200
North Lake, Miller, Mo	150
Artificial Lake, Schell City, Mo	100
Railroad Pond, Lockwood, Mo	150
Patrick Lake, Southbend, Nebr	400
Spring Lake, Benkelman, Nebr	100
Cut-off Lake, Omaha, Nebr	400
Fishing Club Ponds, Hendersonville, N. C	300
Mud Brook Ponds, Hudson, Ohio	200
Highland Park Lake, Cincinnati, Ohio	350
Mad River, Springfield, Ohio	200
Taylors Pond, Cambridge, Ohio	25
Licking River, Claypool, Ohio	250
Silver Lake, Bellefontaine, Ohio	200
Twin Lakes, Earlville, Ohio	50
Muth Lake, Cumminsville, Ohio	300
Stillwater Creek, Pleasant Hill, Ohio	200
Applicants in Ohio	150
Ellison Lake, Guthrie, Okla	200
Youst Lake, Guthrie, Okla	400
Newkirk Reservoir, Guthrie, Okla	200
Applicant in Oklahoma	100
Clarion River, Foxburg, Pa	60
French Creek, St. Peters, Pa	300
Pearl and Shoe creeks, Huron, S. Dak	300
James River, Huron, S. Dak	300
Cedar Creek, Morristown, Tenn	150
Fish Pond, Mason, Tenn	200
Spring Lake, Memphis, Tenn	300
Stegalls Lake, Chattanooga, Tenn	100
Tellico River, Athens, Tenn	200
Piney and Mill creeks, Nunnelly, Tenn	200
Applicants in Tennessee	100
Isaac Lake, Rockdale, Tex	20
Leland Fish Club Pond, Ennis, Tex	15
Applicants in Texas	190
Medleys Mill Pond, Clover, Va	200
Mill Pond, Rock Castle, Va	500
Goose Creek, Leesburg, Va	500
Potomac River, Herndon, Va	500
Fish Pond, Meltons, Va	120
Ohio River, Wellsburg, W. Va	400
Greenbrier River, Lewisburg, W. Va	200
Mississippi River, Glen Haven, Wis	25,000
Fish Pond, Sheridan, Wyo	200
Total	398,511
Strawberry bass:	
Fish Pond, Nashville, Ark	100
Butler Pond, Cuthbert, Ga	90
Carmichael Pond, Augusta, Ga	360
Wells Mill Pond, Smithville, Ga	50
Applicants in Georgia	300
Lake Henrietta, Mansfield, La	100

Species and disposition.	Fingerlings, yearlings, and adults.
Strawberry bass—Continued.	
Lawrence Tank, Mansfield, La	100
Lake Marie, Natchitoches, La	400
Chaplin Lake, Natchitoches, La	200
Mill Pond, Reisor, La	300
Old River, Shreveport, La	600
Red Bayou, Gillian, La	200
Grand Bend Cut-off, Ninock, La	200
Bass Lake, Robeline, La	200
Hays Lake, Reisor, La	100
Lake Julia, Brevelle, La	200
Fish Lake, Natchitoches, La	100
Spring Pond, Bougere, La	200
Fish Club's Pond, Ennis, Tex	50
Total	3,850
Rock bass:	
Applicants in Alabama	200
Verde River, Jerome, Ariz	150
Upper Verde River, Jerome, Ariz	150
Applicant at Globe, Ariz	100
Applicants in Arkansas	400
Fish Pond, Hampton, Ga	300
Mill Pond, Chickamauga, Ga	200
Craw Spring, Waring, Ga	200
Cedar Spring, Adairsville, Ga	100
Applicants in Illinois	1,620
Clinton Pond, Goshen, Ind	150
Applicants in Indiana	1,304
Chickasaw R. and G. Club Pond, Ardmore, Ind. T	300
Fish Pond, Atoka, Ind. T	400
Fish Pond, Comanche, Ind. T	300
Applicants in Indian Territory	450
Crystal Lake, Guthrie Center, Iowa	150
Crossons Pond, Winterset, Iowa	200
Bumps Pool, Grinnell, Iowa	200
Applicants in Iowa	500
Chickaskai River, Wellington, Kans	500
Reservoir, Atwood, Kans	100
Blue River, Blue Rapids, Kans	200
Fish Lake, Kingman, Kans	200
Fish Pond, Langdon, Kans	400
Applicants in Kansas	3,150
Kinniconnick River, Vanceburg, Ky	100
South Elkhorn River, McKinney, Ky	100
Fish Pond, Allenville, Ky	200
Tile Works Lake, Louisville, Ky	200
Applicants in Kentucky	800
Applicant in Louisiana	100
Applicant in Maryland	150
River Basin, Monroe, Mich	300
Fish Pond, Macon, Miss	200
Wanita Lake, Meridian, Miss	200
Fish Ponds, Corinth, Miss	550
Fish Lake, Grenada, Miss	200
Fish Pond, Pheba, Miss	250
Applicants in Mississippi	950
Fish Pond, Lamar, Mo	200
Spring Pond, Kansas City, Mo	250
Stalk Pond, West Line, Mo	250
Fish Pond, Neosho, Mo	500
Fish Pond, Perryville, Mo	200
Fish Pond, Monett, Mo	200
Spring Lake, Schell City, Mo	200
Fish Pond, Kansas City, Mo	250
Hickory Creek, Neosho, Mo	8,900
Applicants in Missouri	600
Applicant in Nebraska	100
Willowbank Lake, Waldwich, N. J	100
Reservoir, Roswell, N. Mex	100
Applicants in New Mexico	400
Riverside Lake, Asheville, N. C	200
Fishing Club Ponds, Hendersonville, N. C	500
Applicants in North Carolina	400
Parrot Pond, Sardinia, Ohio	100

Details of distribution—Continued.

Species and disposition.	Finger-lings, year-lings, and adults.
Rock bass—Continued.	
Woods and Lincoln Park lakes, Cincinnati, Ohio	100
Fish Lake, Lancaster, Ohio	200
Fish Pond, Willoughby, Ohio	200
Gravel Pit, Jamestown, Ohio	100
Applicants in Ohio	400
Fish Pond, Edmond, Okla	200
Fish Pond, Higgins, Okla	200
Fish Pond, Okeene, Okla	200
Fish Pond, Lawton, Okla	250
Fish Pond, Oklahoma City, Okla	400
Fish Pond, Elk City, Okla	400
Applicants in Oklahoma	500
Fish Pond, Reibold, Pa	200
Middle Creek, Fairfield, Pa	700
Fish Pond, Fort Washington, Pa	300
Wrighter and Dunn lakes, Thompson, Pa	300
Clarion River, Foxburg, Pa	300
Applicants in Pennsylvania	400
Knitting Mill Pond, Jonesville, S. C.	200
James Creek Pond, Woodruff, S. C	200
Fish Pond, Winnisboro, S. C	200
Fish Ponds, Fountain Inn, S. C	800
Fish Pond, Norris, S. C	300
Fish Lake, Greenville, S. C	300
Applicants in South Carolina	800
Applicant in South Dakota	100
Buffalo River, Waverly, Tenn	200
Swan Creek, Centerville, Tenn	200
Applicants in Tennessee	700
Railroad Tank, Coleman Junction, Tex	150
Allens Pool, Honey Grove, Tex	75
Hillside Lake, Longview, Tex	100
Moran Pond, Moran, Tex	50
Fish Pond, Marble Falls, Tex	150
Crist Fish Pond, Groesbeck, Tex	75
Fish Pond, Lockhart, Tex	150
Como Pond, Greenville, Tex	250
Reservoir, Mano, Tex	50
Spring Pond, Albany	100
Fitzhugh Lake, Fowler, Tex	200
Loonie Lake, Fowler, Tex	150
Spring Lake, Aquilla, Tex	50
Fish Lake, Marshall, Tex	350
Mill Pond, Texarkana, Tex	25
Fish Pond, Clarksville, Tex	200
Craven Lake, Arlington, Tex	150
Lake Leeches, Alice, Tex	120
Fish Pond, Willis, Tex	100
Redus Pool, Enloe, Tex	50
Briggs Lake, Gilmer, Tex	200
Railroad Pond, Bryan, Tex	100
Reservoir, Panhandle, Tex	30
Spring Lake, Hartley, Tex	190
Reservoir, Beaumont, Tex	150
Railroad Lake, Sadler, Tex	100
Applicants in Texas	2,135
Ice Pond, Lynchburg, Va	100
Tuckers Pond, Petersburg, Va	100
Spring Brook, Bristow, Va	200
Deerfield Pond, Rutherglen, Va	100
Como Spring Pond, Richmond, Va	100
Goose Creek, Plains, Va	300
Fish Pond, Cohoke, Va	200
The Run, Barcroft, Va	320
Swan Creek, Warminster, Va	200
Applicants in Virginia	1,100
Fish Pond, Fairmont, W. Va	200
Fish Pond, Parkersburg, W. Va	200
Private Ponds, Sheridan, Wyo	250
Total	47,844
Warmouth bass:	
Fish Pond, Andersonville, Ga	500
Fish Pond, Oglethorpe, Ga	500
Owens Creek Pond, Brennen, Ga	100
Applicants in Georgia	300
Total	1,400
Sun-fish:	
Fletcher Lake, Opelika, Ala	400
Mill Pond, Opelika, Ala	200
Jones Pond, Opelika, Ala	200
Carpdale Pond, Merry, Ala	200
Fish Pond, Seale, Ala	200
Pettus Lake, Eutaw, Ala	100
Spring Lake, Eutaw, Ala	100
Tyson Pond, Montgomery, Ala	200
Fish Lake, Attalla, Ala	200
Blackwater River, Jasper, Ala	800
Mill Pond, Notasulga, Ala	100
Mealing Pond, Benton, Ala	100
Pratt Lake, Prattville, Ala	100
Bell Fish Pond, Eufaula, Ala	150
Spring Pond, Pratts Station, Ala	100
Fish Pond, Boligee, Ala	100
Fish Pond, Uchee, Ala	300
Rogers Lake, Letohatchee, Ala	200
Camp Creek, Tyler, Ala	100
Fish Pond, Tyson, Ala	400
Beaver Dam Pond, Elba, Ala	350
Spring Creek, Montgomery, Ala	200
Fish Lake, Ozark, Ala	400
Long Branch, Dothan, Ala	100
Applicants in Alabama	1,400
Whitewater Creek, Fayetteville, Ga	200
Lake Mohignac, Columbus, Ga	600
Mill Pond, Americus, Ga	200
Edgewood Pond, Atlanta Ga	200
Busseys Springs, Atlanta, Ga	200
Fish Pond, Griffin, Ga	500
Spring Pond, Pomona, Ga	100
Black Lake, Sylvester, Ga	600
Brooklyn Lake, Forsyth, Ga	150
Hickorynut Branch, Mayfield, Ga	300
German Creek Pond, Thomson, Ga	200
Carmichael Pond, Augusta, Ga	400
Fish Pond, Augusta, Ga	200
Lake, Stone Mountain, Ga	300
Forest Pond, Conyers, Ga	100
Fish Pond, Jefferson, Ga	200
Little South River Pond, Comer, Ga	150
Holly Springs Lake, Americus, Ga	100
Bagley Pond, Americus, Ga	150
McQuester Pond, Culverton, Ga	150
Big Springs, Duluth, Ga	200
Fish Pond, Grovetown, Ga	200
Silver Lake, Chamblee, Ga	300
Fish Lake, Rome, Ga	200
Ombergs Creek, Rome, Ga	200
Mill Pond, Rome, Ga	300
Armuchee Creek, Rome, Ga	800
Grays Mill Pond, Macon, Ga	150
Fish Lake, Summerville, Ga	200
Fish Pond, Geneva, Ga	100
Fish Pond, Thomson, Ga	200
Spring Branch, Younker, Ga	100
Dover Mill Pond, Turnerville, Ga	200
Fish Pond, Woodville, Ga	200
Mill Pond, Thomasville, Ga	300
Town Creek, Oglethorpe, Ga	100
Gold Mine Pond, Kennesaw, Ga	200
Poplar Head Pond, Macon, Ga	100
Augusta Pond, Augusta, Ga	100
Fish Pond, Midland, Ga	200
Wells Mills Pond, Smithville, Ga	300
Leek Creek Pond, Mayfield, Ga	150
Hartman Mill Pond, Roberts, Ga	200
Applicants in Georgia	1,400
Soldiers' Home Lake, Danville, Ill	2,100
Crystal Lake, Litchfield, Ill	350
Applicants in Illinois	800
Mississippi River—	
Savanna, Ill	25,000
Bellevue, Iowa	105,000
Gordons Ferry, Iowa	110,000
Lanesville, Iowa	25,000
McGregor, Iowa	70,000
Clayton, Iowa	35,000

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Sun-fish—Continued.	
Wapsipinicon River, Quasqueton, Iowa	1,200
Cedar River, Cedar Rapids, Iowa	2,500
Maqoketa River, Manchester, Iowa	2,100
Volga River, Volga, Iowa	2,560
Old Reservoir, Louisville, Ky	200
Fish Pond, Lebanon Junction, Ky	200
Hillside Lake, Longview, Tex	100
Fish Lake, Aquilla, Tex	200
Fish Lake, Marshall, Tex	300
Mill Pond, Texarkana, Tex	50
Fish Pond, Clarksville, Tex	200
West Side Lake, Crockett, Tex	400
Silver Lake, Arlington, Tex	500
Railroad Pond, Bryan, Tex	400
Vance Lake, San Antonio, Tex	100
Applicants in Texas	185
Mississippi River, Glenhaven, Wis	30,000
Total	432,545
	Fry.
Cod:	
Great Harbor, Woods Hole, Mass	306,000
Vineyard Sound, off—	
Mouth Woods Hole Harbor, Mass	2,185,000
Jobs Neck, Mass	2,570,000
Tarpaulin Cove, Mass	31,061,000
Robinsons Hole, Mass	9,088,000
Nobska Light, Mass	11,492,000
Quicks Hole, Mass	3,018,000
Atlantic Ocean, Gloucester, Mass	23,493,000
Buzzards Bay—	
North Robinsons Hole, Mass	2,483,000
West of Weepecket Island, Mass	1,380,000
Hadley Harbor, Mass	316,000
Total	87,392,000
Flat-fish:	
Great Harbor, Woods Hole, Mass	59,148,000
Little Harbor, Woods Hole, Mass	707,000
Eel Pond, Woods Hole, Mass	7,402,000
Hadley Harbor, Gosnold, Mass	5,870,000
Atlantic Ocean, Gloucester, Mass	149,666,000
Waquoit Bay, Waquoit, Mass	11,258,000
Atlantic Ocean, Manchester, Mass	11,374,000
Total	245,425,000
Tautog:	
Vineyard Sound, off Parker Point, Mass	519,000
Great Harbor, Woods Hole Mass	4,983,000
Buzzards Bay, off Long Neck, Mass	365,000
Total	5,867,000
Scup:	
Great Harbor, Woods Hole Mass	280,000

Species and disposition.	Fry.
Mackerel:	
Buzzards Bay, off Long Neck, Mass	106,000
Great Harbor, Woods Hole, Mass	175,000
Total	281,000
Sea bass:	
Great Harbor, Woods Hole, Mass	904,000
Vineyard Sound, off Parker Point, Mass	16,000
Total	920,000
Lobster:	
Fishers Island Sound, Noank, Conn	3,000,000
Casco Bay, off—	
Diamond Island, Me	4,200,000
Mackey Island, Me	1,500,000
Cushing Island, Me	3,000,000
Mouth of Fore River, Me	1,500,000
Clapboard Island, Me	1,500,000
Halfway Rock, Me	1,500,000
Back Bay, Me	1,500,000
Peaks Island, Me	1,500,000
Portland Outer Harbor, off light-house, Me	1,500,000
Boothbay Harbor—	
Cape Newagen, Me	500,000
Boothbay, Me	1,000,000
Gulf of Maine, off—	
Richmond Island Harbor, Me	500,000
Wood Island Harbor, Me	500,000
Kennebunkport, Me	500,000
Atlantic Ocean, off—	
Cape Porpoise, Me	1,000,000
Wood Island, Me	1,000,000
South shore of Small Point, Me	500,000
Pemaquid Point, Me	1,000,000
Port Clyde, Me	1,000,000
Rockland Harbor, Me	1,500,000
Kittery Point, Me	3,000,000
York Harbor, Me	3,000,000
Great Harbor, Woods Hole, Mass	6,468,000
Eel Pond, Woods Hole, Mass	148,000
Vineyard Sound—	
Tarpaulin Cove, Mass	1,158,000
Nobska Point, Mass	499,000
Buzzards Bay—	
Robinsons Hole, Mass	363,000
Quicks Hole, Mass	438,000
Scituate Harbor, mouth of Scituate Harbor, Mass	787,000
Atlantic Ocean—	
Gloucester, Mass	16,520,000
Rockport, Mass	2,500,000
Manchester, Mass	1,150,000
Beverly, Mass	800,000
Essex, Mass	600,000
Newcastle, N. H	1,500,000
Total	68,631,000

REPORT ON INQUIRY RESPECTING FOOD FISHES AND THE FISHING GROUNDS.

By Hugh M. Smith, *Assistant in Charge.*

INVESTIGATIONS AND EXPERIMENTS REGARDING SPECIAL ECONOMIC ANIMALS.

OYSTERS.

Experiments at Lynnhaven, Va.—The Commission has continued, under the direction of Dr. H. F. Moore, the oyster experiments at Lynnhaven, Va., the progress of which has been recorded in previous reports. During the preceding years trouble had been encountered in maintaining the salinity of the claire in seasons of great rainfall, and in the autumn of 1902 an appliance was installed for the purpose of obviating the difficulty. It consists of a 14-inch propeller revolving on a vertical shaft in a well connected with the outer waters by a short canal. With the tide at a height of 10 inches above mean level, it is possible to raise the height of the claire one-half inch per hour, and the water lost by evaporation and seepage can be replaced by bay water of maximum salinity. With the water in the claire always maintained at the highest level, rainwater falling on the pond tends largely to keep on the surface and spills over the crest of the dam without considerably lowering the density of the claire. This is an important improvement, as a low salinity makes fattened oysters too fresh, injures their flavor, and lessens their value in the markets.

The difficulty heretofore experienced with an occasional "marshiness" in the flavor of the oysters has been overcome by the use of a lime solution in small quantities and the occasional removal of accumulations of filamentous algæ, which, stimulated by the same artificial conditions which favor the growth of oyster food, tend, under ordinary circumstances, to grow luxuriantly.

Owing to delays in the construction of the propeller pump and to difficulties encountered in its adjustment to the conditions, the claire was not filled with oysters until late in the season. The product was therefore smaller than hoped for and the price realized per barrel was less than would have been the case otherwise. From February 28 to

May 5, 166 barrels were shipped. During April, the only month when the claire was operated at any approximation to its full capacity, 93 barrels were fattened and the average price realized was $4 per barrel.

In order that the system may be commercially applicable a higher price must be received, and to accomplish this it is necessary to be assured of a constant supply of oysters early in the season, when the most advantageous shipping arrangements can be entered into. It is believed that these conditions can be attained during the next fiscal year.

Oysters in Sheepscot River, Maine.—During the summer of 1902 the attention of the Commission was called to the recent volunteer growth of oysters in Sheepscot River, and Dr. W. C. Kendall, who was conducting other inquiries in the vicinity, was directed to make an investigation of the facts. It was found that in general the oysters extend from near the dam at Sheepscot village to about 2 miles above that place wherever they have found proper bottom. It is probable that the area of the beds could be considerably increased by the distribution of suitable cultch. At the time of the settlement of the country productive beds existed in this river, but about 1860 they ceased to exist, although occasional large oysters have been taken from time to time since then. No young oysters were noticed until about 1898, but since then there has been a set of spat each year. Just what change of condition has brought this about is not known, and further inquiry into the matter is contemplated by the Commission.

Oyster planting in North Carolina.—In collaboration with the geological and natural history survey of North Carolina, the Commission has conducted, through the Beaufort laboratory, experiments in oyster culture in Pamlico Sound and Newport and North rivers. The maintenance of experimental beds has been continued with a view to determining the factors, favorable and unfavorable, which confront the commercial oyster planter in North Carolina, and to devise the best means of overcoming the untoward conditions. A subject of some interest, which was under consideration by Mr. O. C. Glaser, was the production of normally shaped oysters from reef oysters and the artificial production of reef oysters from well-shaped ones.

Oyster culture in Japan.—Taking advantage of a visit to Japan by Dr. Bashford Dean, of Columbia University, New York, the Commission arranged to have this well-known biologist investigate and report on the methods of oyster cultivation there pursued. Doctor Dean's report,[a] issued in February, 1903, is the first publication in the English language dealing in detail with the Japanese oysters and their cultivation, and is an important and timely contribution, especially in view of the proposed acclimatization and cultivation of Japanese oysters on the Pacific coast of the United

[a] Japanese Oyster Culture. Bulletin U. S. Fish Commission, 1902.

States. It is reported that during the past winter a considerable consignment of oysters from Japan was planted in Washington waters.

LOBSTER.

Lobster rearing.—Experiments in the hatching and rearing of lobsters were continued at Woods Hole during the summer of 1902, in charge of Mr. George H. Sherwood. A special floating nursery was constructed and moored at the head of Great Harbor. Eggs and newly-hatched larvæ were supplied from the Woods Hole hatchery as required, and other facilities of the station were freely used. Considerable progress was made beyond the previous year's work, and it is believed that the methods which have now been developed are practicable for operations on a large scale. One of the chief drawbacks this season was the extraordinary abundance of minute diatoms which thickly covered eggs and larvæ, and seriously interferred with hatching and growth. A final and complete report on the lobster-rearing experiments will soon be made by the special commission having this matter in charge.

Handbook of the lobster.—Interest in the lobster continues unabated among fishermen, legislators, state fishery authorities, and biologists, and there is a very active demand for printed information in regard to the habits, growth, spawning, development, etc., of the lobster, as well as the methods and extent of the lobster fisheries. The monographic work on the American lobster by Prof. F. H. Herrick, published by the Commission about seven years ago, is now out of print and no other report on the general subject is available for distribution. With a view to supplying the demand, the Commission has decided to issue a handbook on the lobster and its fisheries, and to this end has engaged Professor Herrick to condense and bring up to date his work referred to. During the summer of 1902 Professor Herrick visited the important lobster fishing communities on the coast and collected much new material on the natural history of the lobster. The lobster fisheries, lobster legislation, lobster rearing, and other matters connected with the economic aspects of the subject will be discussed by Dr. H. M. Smith.

BLUE CRAB.

The recent increase in the catch of blue or edible crabs in Chesapeake Bay, where the fishery was already of great extent, and the appearance in the eastern markets of large quantities of soft-shell crabs of very small size, has led to the belief that the supply of crabs may be declining. The Commission therefore decided to begin an inquiry into the habits, breeding, abundance, etc., of the crab in Chesapeake Bay, and assigned Prof. W. P. Hay to the work, in conjunction with his study of the diamond-back terrapin in the same waters.

Many points were visited and observations made in all parts of the bay, and considerable new light was thrown on the habits of this crab. The information thus collected will be of value should it become necessary to enact measures for protecting the species. Among the interesting facts apparently established are: (1) that in Chesapeake Bay the blue crab seldom or never produces eggs at any great distance from the ocean, and therefore that the myriads of adult crabs found in the upper waters of the bay represent young crabs which have migrated thither from the denser waters near the Virginia capes; (2) that the crab produces eggs only once, and dies shortly after spawning; and (3) that the males undoubtedly live longer than the females, great numbers of large adults surviving the winter by burying themselves in the mud in the deeper channels.

DIAMOND-BACK TERRAPIN.

The growing scarcity of the diamond-back terrapin in Chesapeake Bay, which has for years been the most productive region, has led to the belief that the species may eventually become almost exterminated if the present methods of the industry continue, or if no steps are taken to arrest the decline by cultivation. The reported catch of terrapins in Maryland in 1901 was only one-sixtieth of the quantity and one-twentieth of the value of that in 1891; and in Virginia the output in 1901 was one-tenth the quantity and one-thirteenth the value of that for 1891. The decrease in the local output has in part been made good by the importation by the dealers of terrapins from the South Atlantic and Gulf States—these southern terrapins being kept for a while in pounds and then shipped to market. There have been many requests for data regarding the growth, food, breeding, etc., of the terrapin, but the only report on the subject, published many years ago, is out of print and much of the information therein contained is obsolete and incomplete.

During the summer of 1902 a complete study of the diamond-back terrapin of the Chesapeake Bay region was undertaken by the division, Prof. W. P. Hay being placed in charge. In addition to the natural history of the species, there were considered the extent and causes of the decrease, the laws regulating the terrapin fishery, terrapin pounds and their management, the trade, markets, prices, etc. Special atten-was given those points in the natural history of the species which bear on the question of artificial rearing, and a series of experiments was inaugurated addressed to this phase of the subject. Supplemental to this inquiry, an experimental pound was established at a favorable locality on the Choptank River, Maryland, and another at the laboratory at Beaufort, N. C., for the purpose of keeping terrapin under observation and noting their growth, breeding habits, etc.

There was also taken up a study of the diamond-back terrapin from the standpoint of systematic zoology, and specimens were collected and brought together in Washington from Delaware, Maryland, Virginia, North Carolina, Florida, Mississippi, Louisiana, and Texas in order to determine the specific or varietal differences.

The inquiries and experiments will be conducted during another season, after which it is hoped that a final report on the biology of the diamond-back terrapin may be made and that a practicable method of cultivation may have been developed.

PACIFIC SALMONS.

Salmon fisheries of Alaska.—The unusual activity displayed in the Alaska salmon fisheries during the last few years, the remarkable extension of the fisheries, the great increase in the amount of gear used and in the number of canneries operated, together with the very close competition among the different companies, each striving to secure as large a pack as possible, made it evident that the demand upon the salmon supply was greater than could be met by natural reproduction. Fearing a serious depletion of the fisheries, the President, under date of November 8, 1902, requested the Commissioner of Fish and Fisheries to appoint a special commission to make a study of the condition of the salmon fisheries of Alaska, the efficiency of the existing regulations under which they are carried on, and the necessity for artificial propagation, and to submit a report embodying such recommendations as might be thought needful for the proper regulation and preservation of those important fisheries. The special Alaska salmon commission consisted of Dr. David S. Jordan, president of Stanford University; Dr. Barton W. Evermann, assistant in charge of the division of statistics and methods of the fisheries; Lieut. Franklin Swift, U. S. Navy, commanding the *Albatross;* Mr. A. B. Alexander, fishery expert on the *Albatross;* Mr. Cloudsley Rutter, naturalist on the *Albatross;* and Mr. J. Nelson Wisner, field superintendent of fish-cultural stations. In addition to the regular members, the following assistants to the commission were appointed: Mr. F. M. Chamberlain, Mr. E. L. Goldsborough, and Mr. H. C. Fassett, of the Fish Commission; Dr. Harold Heath, Dr. C. H. Gilbert, Mr. M. H. Spaulding, and Mr. Harold Jordan, of Stanford University, and Mr. A. H. Baldwin, of Washington, as artist.

The steamer *Albatross* was detailed for use during the investigations, but before the ship went north shore parties for the study of certain phases of the salmon fisheries were established as follows: Early in March Mr. Chamberlain went to Loring, Revillagigedo Island, in southeast Alaska, where he entered upon a study of the habits of the salmon, which it is expected will be carried on continuously for at least one calendar year. One of the largest salmon canneries of Alaska and

the largest and best equipped salmon hatchery in the world are located here, and the place affords exceptional opportunities for a study of four of the five species of Alaska salmon. In May Mr. Rutter and Mr. Spaulding established a similar station at Karluk on Kadiak Island. The facilities for a study of the salmon are unsurpassed at Karluk. Karluk River is one of the best salmon streams in Alaska; there are two well equipped canneries at its mouth, and the Alaska Packers' Association operates an extensive salmon hatchery at the head of the lagoon. Early in June Doctor Gilbert was sent to Bristol Bay, Bering Sea, where he entered upon similar studies of the salmon and salmon fisheries of that region. At the end of June all these investigations were in progress and were carried over into the next fiscal year. The *Albatross*, with the other members of the commission and their assistants on board, sailed from Seattle for Alaska, June 18, and the investigations were in progress at the close of the fiscal year.

Blueback salmon in Baker Lake.—In conjunction with the operations of the hatchery for blueback salmon on Baker Lake, at the head of Skagit River, Washington, the superintendent desired to have certain biological investigations undertaken, and Mr. Cloudsley Rutter was assigned to the inquiry. One of the questions raised by the superintendent was whether there was sufficient natural food in the lake and its tributaries to support the young salmon liberated by the hatchery. When the lake was visited in November young salmon were found to be abundant, but no more so than other salmonoids usually are in suitable waters. It seems to be established that many of the bluebacks go downstream at an early age, and there is food enough in the lake for all that remain. Young silverside salmon were more abundant than bluebacks, although bluebacks are much more extensively propagated than the others. In view of the importance of the Baker Lake station, as the only known place in the Puget Sound region where the valuable blueback salmon can be artificially propagated on a large scale, it seems desirable that there should be a thorough study of the entire Skagit basin with reference to the movements, spawning, etc., of the salmon. From the information already at hand it seems probable that there are other sites suitable for hatcheries on the Skagit or its tributaries.

Natural history of the quinnat salmon.—The investigations of the quinnat salmon in the Sacramento basin, which had been in progress for a number of years under the charge of Mr. Cloudsley Rutter, assistant of the Commission, were incorporated in a report[a], issued in March, 1903, which is an important contribution to the knowledge of this valuable fish. Supplementary inquiries addressed to special points in the life of the quinnat salmon of the Sacramento were carried on during September, October, and November, 1902, by Mr. Rutter and

[a]Natural History of the Quinnat Salmon. A report on investigations in the Sacramento River, 1896-1901. Bulletin U. S. Fish Commission, 1902.

Mr. F. M. Chamberlain. One of the topics considered was the movements of spent salmon, more especially the tendency of spent fish to move downstream. The season was unfavorable for observations in Battle Creek, the point selected for this purpose, and the data obtained were meager; a few spent fish were caught and tagged, and some of these were subsequently taken in a trap above the place of release, but none was caught below. A site suitable for a branch hatchery for the summer run of salmon was found on Battle Creek, opposite the mouth of Baldwin Creek; the advantages of the place are a gravity supply of water, facilities for placing a rack, seining grounds, and spawning beds.

The effects of light on developing salmon eggs were determined by experimental tests at Battle Creek hatchery in November. These proved that eggs are injured by sunlight and light on a cloudy day up to the age of 3 weeks; before the age of 2 weeks the eggs thus exposed will die in twenty-four hours; after that age there is greater resistance but still considerable loss. When a basket of young salmon eggs is placed in the light, the eggs in the top layer will die, while the deeper eggs are uninjured; and if one end of a basket is sheltered the line of demarcation is sharply defined by the number of dead eggs on the two sides. Inside the hatchery, eggs in an open basket, in a basket covered with the ordinary trough screen, and in a basket inclosed in a light-proof box opened only by candlelight exhibited no appreciable differences in percentage hatched or in health of fry. Prof. C. W. Greene continued his studies of the physiology of the Sacramento quinnat salmon, making observations and experiments on salmon at sea, in the lower course of the river, and at the spawning grounds in the headwaters at Monterey, Black Diamond, and Baird, respectively. Mr. Rutter assisted in this work.

ATLANTIC SALMON.

Salmon of Penobscot Basin.—The investigation of the inland waters of Maine, on which Dr. W. C. Kendall has been engaged for several seasons, was continued during the first four months of the fiscal year, most attention being devoted to the salmon of Penobscot River, especially the young salmon of the East Branch. The basin of this stream was thoroughly explored, including its two principal tributaries, Wissataquoik River and Sebois Stream, together with numerous brooks and lakes. It is alleged that owing to artificial obstructions but few salmon are able to ascend the East Branch, and only a few adult fish were observed above Grindstone, at the mouth of Wissataquoik River; it is possible, however, that there were other fish lying concealed in the deep pools. Although salmon are said to have been very scarce for the past few years on their spawning beds, young salmon evidently of this year's hatching were fairly numerous in all suitable places in

the main stream from the Wissataquoik to Grand Pitch, and were common in Wissataquoik and Sebois rivers and in nearly every spring brook. While these young salmon had attained a length of only 5 to 6 inches, those found between Grand Pitch and the dam at the foot of Matagamon Lake were from 6 to 10 inches long. These larger fish have been mentioned in previous reports as peculiar in that the males were sexually mature; but it was found that even smaller fish from farther downstream showed the same condition and apparently when only a few months old. A number of young salmon were marked by attaching small copper tags to their dorsal fin, for the purpose of determining their movements and rate of growth.

Landlocked salmon in Massachusetts.—Some attempts have been made to stock with landlocked salmon certain Massachusetts ponds, and further requests for fish for stocking purposes having been received, it was deemed advisable to determine whether the ponds are adapted for salmon and to ascertain the results of the plants already made. In November, 1902, Mr. Vinal N. Edwards, of the Woods Hole station, was detailed to visit the ponds in question, which are near Osterville, in Barnstable County, and to make observations on their size, depth, temperature, character of bottom, vegetation, and animal life. A dredge and a seine were used in collecting specimens of fish, etc., and fishing trials were made with hook and line. Following are the results of the examination of these ponds as reported by Mr. Edwards:

Neck Pond.—Area, 50 acres; depth, 35 feet; 100 feet from shore there is a depth of 25 feet all around the pond; temperature November 10, 1902, 46° F. at surface, 44° at bottom; no outlet; water can not be drawn off. Pond surrounded by trees and by a white sandy beach 10 to 20 feet wide; bottom gravelly to depth of 25 feet, then sandy, with grass (which is very thick in some places).

Dredged all over pond, but found very little animal life in the grass. Water so deep that seining was impossible except close to shore; there caught yellow perch and minnows. Other fish found in the deeper parts of the pond are brook trout, black bass, several kinds of small fish, and landlocked salmon. In October, 1900, 1,000 young landlocked salmon were planted here. When fishing for a few minutes in the middle of the pond with saltwater shrimp, two salmon were caught and two others were brought to the surface; then, the shrimp being expended and minnows being used, only large yellow perch were caught. It is reported that everyone who has fished for perch with shrimp-bait has taken some salmon.

Michaels Pond.—Area, 25 acres; depth, 30 feet; temperature November 11, 53° F. at surface and bottom; shores gravelly; bottom hard, covered with grass; no shade; water not so clear as in other ponds; no outlets or inlets; water can not be drawn off.

Pond contains an abundance of yellow perch, horned pouts, and minnows. Seven years ago 5,000 rainbow trout were planted, but none has since been seen.

Grigsons Pond.—Length, 1¼ miles; width, three-fourths to 1 mile; half the pond is 80 feet deep, the deep water close to shore; temperature November 10, 54° F. at surface, 52° at bottom, summer temperature said to reach 70°; little shade; very clear; sides gravelly to depth of 30 feet, beyond that mostly hard bottom covered with grass; no outlets or inlets; water can not be drawn off.

Black bass, pickerel, and yellow perch abundant; a few brook trout said to occur; no salmon ever planted here.

It therefore appears that Neck Pond has been rather well stocked with landlocked salmon and that at least one of the other ponds is adapted to it, although it may be questioned whether these waters will permanently support a good supply of salmon in view of the abundance of the predaceous fishes therein.

It may be mentioned, as bearing further on the suitability of Massachusetts waters for this species, that a pond in East Falmouth, near Woods Hole, is plentifully stocked with the fish, many being taken by anglers in the summer of 1902, some of which weighed 4 pounds; and that Long Pond in Falmouth has also been successfully stocked.

CARP.

The study of the carp in Lake Erie was continued by Mr. L. J. Cole during June, 1903, and a full report on this subject will shortly be completed. Making his headquarters in the region of Sandusky, Mr. Cole gathered further information on the breeding habits of the carp, the relations of the carp to aquatic vegetation, the introduction and increase of carp fisheries, and effects on the movements of the carp of the changes in the water level so prevalent in the region.

CAT-FISHES.

Both commercial fishermen and anglers throughout the country are showing an increasing interest in the various species of cat-fishes, and the requests for cat-fish for stocking public and private waters have been numerous. It is possible that it will soon become necessary for the Government to undertake extensive fish-cultural measures addressed to certain species in order to meet the growing demand. The establishment of a special cat-fish breeding station in the South has also been suggested. There has been but little information published in regard to the spawning habits of the cat-fishes, and practically nothing is known of the breeding and other habits of some of the most important species. Some specimens of the common bullhead or yellow cat-fish (*Ameiurus nebulosus*) which spawned at central station, Washington, D. C., in July, 1902, were kept under close observation and served as the basis for a paper[a] in which the nest making, spawning habits, eggs, incubation, care of eggs and young, and growth of young were described. In another paper[b] there were brought together many notes, mostly extracted from published records, on the food value, food and feeding habits, acclimatization, etc., of some of the best-known species.

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[a] Breeding Habits of the Yellow Cat-fish. By Hugh M. Smith and L. G. Harron. Bulletin U. S. Fish Commission, 1902.

[b] Habits of Some of the Commercial Cat-fishes. By W. C. Kendall. Bulletin U. S. Fish Commission, 1902.

TILE-FISH.

The recent reports of the Fish Commission have had references to the abundance of tile-fish (*Lopholatilus chamæleonticeps*) off the southern New England and Middle Atlantic coast, and to the efforts of this bureau to create a demand for the fish that would lead to the establishment of a fishery. The numerous requests for the fish from wholesale and retail fresh-fish dealers and from curers, who were desirous of making known to the public the edible qualities of this fish, induced the Commission to undertake to obtain another supply for gratuitous distribution. Accordingly, the schooner *Grampus*, sailing from Woods Hole on July 30, 1902, made a short trip to the most easily reached grounds. On July 31, 76 miles SE. by S. of No Mans Land, in latitude 40° 10′ 45″ W. and longitude 70° 20′ 30″ N., the fishing trials were made, five lots of trawls being set about the vessel, in water 65 fathoms deep. Fresh menhaden and frozen squid were used for bait, the former appearing to be the better. The results of the fishing were as follows, the trawls being left down two hours:

Set No.	Tubs of trawls.	Hooks.	Fish caught.
1	3	1,050	102
2	3	1,050	78
3	4	1,400	128
4	3	1,050	99
5	2	700	67

The number of fish caught was 474, ranging in weight from 3 to 40 pounds, and the aggregate weight was estimated to be between 7,000 and 8,000 pounds. This was the largest catch of tile-fish ever made, and, considering the very short time the trawls were left down, the trials confirm the previous indications of the remarkable abundance of this species. A vessel equipped with the fishing gear of the Boston and Gloucester fresh-fish fleet should be able to take 50,000 pounds in a day's fishing.

The fish were landed at Woods Hole and shipped in ice in small lots to many well-known firms in Gloucester, Boston, New York, and elsewhere, by which they were distributed to hotels, clubs, and private customers. Enough has probably been published to show the general sentiment as to the edible qualities of the tile-fish, but the following information and special opinions in regard to the market value of this year's catch may not be without practical interest:

Thirty fish were sent to the members of the Boston Fish Bureau. The secretary reported that the fish were held to be good and that the members believed there was a satisfactory market for them. One member thought the fish tasted like the red snapper and another said it greatly resembled the striped bass in flavor.

Mr. A. F. Rich, wholesale fish dealer and commission merchant, of Boston, received 126 pounds of fish and "disposed of them among several fish markets, charging them 5 cents a pound, and they sold all of them at a profit and have been asking for more."

Messrs. John Pew & Son, owners of fishing vessels, curers, and wholesale dealers, Gloucester, Mass., wrote: "We had heard considerable about these fish, but had never had the opportunity of examining them or eating them. It seems to us that they would be quite an addition to the food supply of the country if the quantity easily taken could be assured. We tried them under various forms, and they are certainly palatable, and would find a ready market, we think. We would prefer the cod and haddock, however, to the tile-fish."

The J. Maddock Company, wholesale fresh-fish dealers, Boston, wrote: "We are of the opinion that a ready market can be found for this fish at a fairly good price, say, about 5 to 10 cents per pound. We trust that you may be successful in arousing interest among the fishermen in the catching of this fish."

Mr. W. H. Prior, wholesale fresh-fish dealer, Boston, reported that he sold the barrel of tile-fish sent him for 12 to 15 cents a pound, and that they gave perfect satisfaction.

In order that the value of the tile-fish in the dry-salted and boneless states might be determined, about 1,000 pounds of fresh fish were sent to a curer in Gloucester. When split and dry-salted, like cod, and also when prepared like boneless cod, it was found that the tile-fish is a very satisfactory food, the muscles being thick, flaky, and well-flavored. The objections to the tile-fish when cured are purely æsthetic, the flesh being of a somewhat darker color than that of cod and being slightly discolored by fat, which is more plentiful than in the cod. When slack-salted and smoked, the tile-fish is reported to be excellent.

It is interesting to be able to announce the first deliberate attempt to catch tile-fish on the part of a regular fisherman. The information is communicated by Mr. William H. Jordan, of Gloucester, who writes as follows, under date of October 4, 1902:

Captain Langworthy, of Noank, Conn., is superintending the building at Essex of a vessel he will command in the fishing business, and is here at intervals. He became interested in the information about the tile-fish which I furnished him as originating with you. He saw those we have cured on the wharf, and, without announcing his intention, went to Stonington, where there is a fishing yacht named the *Gazelle*, owned by Captain Atwood, who keeps her for pleasure, but is an old fisherman. They made a trip, south by east from Block Island, until they struck 56 fathoms of water, and they found the fish in abundance. As fast as a hand line would reach the bottom it secured a fish. They had a short piece of secondhand haddock trawl, which they set and obtained quite a quantity of fish. These fish they did not attempt to market, but gave away, as they simply went to verify the information that Captain Langworthy had received. I think he will try this fishing next winter, when his new vessel is ready.

The capture of a tile-fish on Quero Bank by a cod-fishing vessel greatly extends the previously known range of the species. It appears that about December 15, 1902, the schooner *Monitor*, of Gloucester, caught a small tile-fish on the eastern edge of Quero, in latitude 44° 26′ N. and longitude 57° 13′ W., in 170 fathoms of water. The specimen was seen and identified by Capt. S. J. Martin, agent of the Fish Commission at Gloucester, and by various other persons who are familiar with the species.

COMMERCIAL SPONGES OF FLORIDA.

Survey of the sponge grounds.—The steamer *Fish Hawk* continued the survey of the sponge grounds off the Florida coast, beginning work at Cape Sable on December 17, and concluding in the vicinity of Cape Florida about the end of February. During this period all the sponge grounds of the east coast were examined and plotted, thus concluding the survey of the sponge-bearing bottoms of the state begun several years ago. Complete collections of sponges were made, and much information was acquired in regard to the productivity of the sponge grounds, the comparative abundance of the different kinds of sponges on the various grounds, etc. Experiments were undertaken to test the feasibility of transporting sponges alive in aquaria on the ship, but without marked success. During the course of the survey lines of dredgings and soundings were run at right angles to the coast, in order to determine the general character of the bottom fauna on the inner edge of the Gulf Stream, and considerable collections of valuable material were made.

Sponge culture.—During the year the experiments in sponge culture have been continued under the direction of Dr. H. F. Moore, at three different points on the coast of Florida. Practically the same methods have been followed as during the preceding year, but additional materials for attachment have been tried in order to determine the cheapest and most durable. As stated in previous reports, the method which appears to give the best results, having due regard for the requirements of a commercially profitable industry, is the attachment of the cuttings to wires fastened to stakes driven into the bottom about 50 feet apart, in such manner that they are suspended free of the bottom. It has been determined that the cuttings not only grow more rapidly and of more regular shape when suspended freely in the water, but that a larger proportion survive. Numerous parallel experiments, where the free suspension of the cuttings in one case was the only difference in the conditions, show indubitably the advantage of raising the wires above the bottom. When the cuttings are not suspended, wave movements produce attrition upon the bottom and subsequent abrasion of the surface of the sponge, and the mortality rate is high, especially during the early stages of growth.

The deposit of silt and the overgrowth of vegetable matter in portions of the sponge also restrict the growth, causing not only a reduction in weight, but an irregularity of form which reduces the market value. When the cuttings are suspended the ultimate shape, whatever be the original shape of the cutting, is invariably regularly spherical or ellipsoidal. From a commercial standpoint the method is manifestly an improvement upon nature's, for the suspended sponge is more advantageously situated as regards water currents and food sup-

ply; it grows more rapidly than when at the bottom; it is more regular, and there is no "root," the portion of the sponge which in service proves itself least durable.

As stated in the report for the preceding fiscal year, the cuttings are in general subcubical in shape and about 2 cubic inches in volume. They are cut from the live sponges with a sharp knife, and each has at least one face covered by the original skin. A slit about 1 inch in depth is made parallel to the longest axis and placed astride the suspension wire. A piece of aluminum wire about 4 inches in length is thrust through the two flaps and the ends twisted around the suspension wire in such manner as to close the slit. Within a week the opposed faces of the slit unite and the cutting heals around the suspension wire.

The general system already evolved is believed to be that which will ultimately obtain in practice, but the ideal material for the suspension lines has not yet been found. Copper wires with okonite and underwriter's insulations, asbestos cord, thin manila and cotton rope, and stranded galvanized iron wire were the materials first employed. The ropes quickly rot, and within a year the okonite insulation softens and breaks from the wire, so that the exposed copper is acted upon by the sea water and weakens to the breaking point. Underwriter's wire, a much cheaper insulation and inferior for electrical purposes, lasts much longer, but at the end of the fiscal year lines which had been in use eighteen months were beginning to lose their insulation in places. A heavier wire and thicker covering than that already employed would doubtless be more durable. Asbestos cord, which is about twice as costly as the underwriter's wire, is slightly, if at all, acted upon chemically by the sea water, but when wet the fibers become slippery and the tensile strength of the cord is much reduced. When the sponges are large the strain on the line becomes considerable, especially during storms, and it is doubtful whether plain asbestos cord will prove sufficiently strong. Experiments now under way indicate, however, that by suitable treatment the strength of the wet cord may be more than doubled without materially increasing the cost.

The organic attachment of the cuttings to the suspension wire is advantageous, but not essential. The condition has been attained with none of the materials above enumerated, and during the present year experiments have been conducted with the accomplishment of this end in view. Lead has proved to be the most satisfactory material, as it is but little affected by sea salts and the cuttings soon become fixed. Lead wire is useless on account of its lack of tensile strength. Lead-covered insulated copper wire is too heavy, or, if made sufficiently light, the lead casing is so thin that it breaks, cuts the insulation, and, coming into contact with the copper, establishes a destructive electrolytic action. To overcome these several difficulties,

ordinary marlin with a lead covering one thirty-second of an inch thick was employed, with results that were satisfactory at the end of a trial of eight months. It is possible that marlin may rot in a period of time shorter than that required for the maturing of the sponges, in which event the material will have to be abandoned.

On the whole, the progress of the work has been encouraging. Cuttings which originally measured 1 by 1 by 2 inches have in eighteen months grown into spheroids in some cases 4 inches in diameter, or twenty-five times the original weight. These sponges are larger and heavier than the minimum size marketed from the natural beds. The proportion of survivals after sixteen to eighteen months varies with the condition of the experiment between 45 and 95 per cent. Though the experiments have not reached a conclusive stage, the results so far attained are such that a firm engaged in the sponge business has begun operations on a commercial scale, the results of which will be available for the information of the Commission.

AQUATIC RESOURCES OF HAWAII AND SAMOA.

At the close of the fiscal year 1902 the steamer *Albatross* was engaged in an investigation of the fishes and other aquatic resources of the Hawaiian Islands. These investigations were under the general direction of Dr. David S. Jordan, president of Stanford University, and Dr. Barton W. Evermann, of the Fish Commission. The investigators on board the *Albatross* were Dr. Charles H. Gilbert, Prof. John O. Snyder, and Mr. Walter K. Fisher, of Stanford University; Dr. Charles C. Nutting, of the University of Iowa, and Mr. A. B. Alexander and Mr. Fred M. Chamberlain, of the permanent staff of the *Albatross*. The work continued until August 30, when the ship returned to San Francisco.

During the conduct of this survey most of the islands of the Hawaiian group were visited. Dredging was carried on in the channels and on the banks among the islands, shore collecting was done whenever practicable, and the abundance and values of the different commercial fishes as seen in the markets at Honolulu and elsewhere received attention. Knowledge of the shore fishes was greatly increased, many species not previously known having been found. Deep-water dredging about the islands proved exceedingly difficult, owing to the roughness of the lava and coral bottom; the trawls were frequently torn and sometimes entirely carried away. Nevertheless, large and valuable collections were obtained, including many species of fishes, mollusks, crustaceans, and other invertebrates, either previously unknown or very rare.

A visit was also made by the *Albatross* to the Leeward Islands, some 800 miles northwest of Honolulu, giving an opportunity to determine the extension of the Hawaiian shallow-water fauna in that direction

and to land on Laysan Island, which is of very great interest on account of immense numbers of birds that have their breeding grounds there. The amount of sea food which this vast multitude of birds takes from the ocean probably exceeds a thousand tons daily. As this food doubtless consists wholly of either fish or food of fish, the importance of aquatic birds in their relation to the fisheries becomes at once apparent.

The large collections made during the Hawaiian investigations of 1901 and 1902 have been assigned to specialists in the various groups, and the reports are now in course of preparation. It is expected that the report by Doctor Gilbert on the deep-water fishes of the Hawaiian Islands will soon be ready for publication, and that the final report by Doctor Jordan and Doctor Evermann, containing descriptions and illustrations of all the species of fishes known from those islands, will soon follow.

The investigations by the Commission of the fishes and other aquatic life of the Hawaiian Islands naturally led to a consideration of the origin of the Hawaiian aquatic fauna and its relation to that of the islands to the southward. It was therefore arranged that Doctor Jordan should spend the summer of 1902 at the Samoan Islands making collections of the fishes of that group. Doctor Jordan sailed for Apia in May, 1902, accompanied by Prof. Vernon L. Kellogg and Mr. Michitaro Sindo, and returned in August following, bringing with him a very large collection, embracing about 600 species of fishes, many of which are new to science. This collection is now being studied by Doctor Jordan, and the report will be published by the Commission.

SPECIAL INQUIRIES IN JAPAN.

The Commission having decided to make a study of certain biological and other phases of the fisheries of Japan in the interest of the fishing industry of the United States, Dr. H. M. Smith was detailed to this duty in the latter part of the fiscal year. Besides making a general survey of the Japanese fisheries, which are among the most extensive and interesting in the world, attention was directed to certain special branches in which the Japanese have attained prominence and which are of practical importance to the United States, among them being the cultivation and utilization of marine algæ, the production of pearls in mollusks by artificial means, and the culture of terrapin. Another subject of special study was the dwarf salmon—its habits, growth, distribution, food value, cultivation, etc.—with a view to determining the feasibility of its acclimatization in the United States. The advisability of introducing some of the Japanese fishing and curing methods into the United States, and the opportunities for promoting the fishery trade of the two countries, were also considered.

The Japanese minister to the United States very courteously acquainted his Government in advance with the purposes of the investigation, and the Japanese Government, through its department of commerce and agriculture, extended every facility and made most ample provision for the prosecution of the inquiries, detailing different members of the imperial fisheries bureau to accompany the Commission's representative on his travels to the fishing districts. The thanks of the Commission are due especially to Hon. N. Maki, director of the imperial fisheries bureau, and to his efficient assistants, Doctors Kishinouye, Oku, Kitahara, Nishikawa, and Nishimura. Many courtesies were also extended by officials of various local governments, as well as by private citizens in all places visited.

At the request of the Imperial Fishery Institute in Tokyo, Doctor Smith delivered an illustrated lecture on the organization and work of the United States Fish Commission, and, at the solicitation of the Imperial Fisheries Society, he gave an illustrated lecture in Osaka on the fishery industries of the United States.

DISEASES AND PARASITES OF FISHES.

GENERAL STUDY OF FISH DISEASES.

Routine consideration of the diseases affecting domesticated and wild fishes has been given by Mr. M. C. Marsh, the assistant assigned to the subject of fish pathology; and numerous investigations have been made in the interests of the Commission, various States, and private owners of fish ponds or fish-cultural establishments.

The cause of the destructive epidemics among artificially reared brook trout, referred to in previous reports, has been definitely traced to a germ, of which a full account has been published.[a] This organism was obtained from the blood of diseased brook trout and stands in specific causal relation to the disease. It is a pleomorphic form, which appears in the blood and local lesions of its host as longer or shorter rods with occasional spherical forms. It is pathogenic particularly to the brook trout (*Salvelinus fontinalis*), but has been isolated from Loch Leven trout (*Salmo trutta levenensis*) in epidemic, and in a few cases from the lake trout (*Cristivomer namaycush*). It has been found only in domesticated or aquarium fish and never in wild trout from natural waters. Healthy brook trout succumb to the disease in a few days by direct inoculation beneath the skin into the peritoneal cavity or into the orbital cavity, and after a longer time by mixing cultures with their food; the organism recoverable in all cases from the heart blood. Inoculation into the dorsal lymph sac of a frog of 1 per cent of its

[a] Bacterium Truttæ, a new Species of Bacterium Pathogenic to Trout: Science, xvi, 706–707, October 31, 1902. A More Complete Account of Bacterium Truttæ: U. S. Fish Commission Bulletin, 1902, pp. 411–415, 2 pl.

body weight of a bouillon culture was negative, the frog showing no effects. Trout dead of the disease may be eaten, after ordinary cooking, without ill effects. A cat has habitually eaten and thrived upon the fresh, uncooked bodies of the dead trout, and the organism is probably not pathogenic to any warm-blooded animals. Attempts to stain flagella have had negative results, and the species is placed in *Bacterium* and named *truttæ* for the group of fishes that apparently contains its chief hosts.

In February, 1903, in response to a request of the Surgeon-General of the Public Health and Marine-Hospital Service, the Commission detailed Mr. F. M. Chamberlain, assistant on the steamer *Albatross*, then at San Francisco, to cooperate with the representative of the Service and of the health department of San Francisco in a special inquiry growing out of the efforts to eradicate the plague from the Chinese quarter of San Francisco. It being proposed to bring about a wholesale destruction of rats in the sewers by means of poisons (such as arsenic and phosphorus), the authorities desired to have an assistant of the Commission keep watch at the outlets of the sewers to note the effects of such poisons on the fish life of San Francisco Bay, and if it appeared that injury was resulting, to suggest modification in the methods of procedure.

EFFECTS OF POLLUTED POTOMAC WATER ON FISHES.

In the case of the United States against a local company, charged with violating section 901 of the code of the District of Columbia, this Commission became interested because of the alleged contamination of the Potomac River by refuse from gas works and the effects thereof on fish life. In November, 1902, the police authorities submitted to the Commission a sample of over 20 gallons of water from the Eastern Branch of the Potomac, with the request that it be examined with reference to its effect on fishes, the water having been taken from a point near the place where refuse products from gas manufacture were said to be entering the river. The water was of a very dark color, almost black, and full of sediment, a considerable quantity of black tarry mud having been introduced; an iridescent scum was present, and the odor of coal tar was very marked.

About 6 gallons of this water immediately poured into a glass aquarium jar, artificial aeration was begun, and three large-mouth black bass about 6 inches in length were introduced; these were dead at the end of forty minutes. A control experiment of three bass of the same size in Potomac service water, with aeration, was carried on at the same time; the control bass did not suffer. In each experiment described a corresponding control continued throughout the experiment, unless otherwise indicated.

A considerable sediment was kept in circulation by the aerating current, and as this sediment deposited in the gills to a slight extent and might be held to injure mechanically, the agitation due to the air was excluded by repeating the trial with two black bass, without aeration, using a new sample of the polluted water. These bass died in one hour, the unaerated controls being unaffected. The agitation caused by the struggles of the fish, however, kept the sediment distributed about as much as the air current had previously done.

After the remainder of the sample had stood over one night and it had cleared considerably by sedimentation, about 5 gallons were siphoned from the middle of the can, so that all the sediment and the surface scum were excluded. Into this water were introduced three carp between 5 and 6 inches in length, four sun-fish of about 4 inches, four calico bass of 3 inches, and two rock bass of 1½ inches. All died within two hours, the gills free and unclogged, the controls being unaffected.

The next day, using the same sample of water, into which the air current had been running all night, two very small cat-fish and one of about 7 inches were introduced. The two small ones died in twenty and forty-eight hours, respectively, while the larger one was still alive at the end of two days, but in distress. The water was then replaced by a fresh sample of the polluted water from the fish can, and the large cat-fish succumbed in three hours. The aeration seemed to purify the polluted sample, evidenced by the reduction in the strength of the odor and by the fact that the cat-fish survived in it much longer than in a fresh sample from the can.

After the remainder of the sample had stood seven days in the can it became comparatively clear. A portion of the clear water was poured off without excluding a small amount of scum and the iridescent film on the surface, and in it were placed one small calico bass and one small rock bass. The former died in one and one-half hours, the latter in one hour, the controls living and normal.

The water after settling for seven days was neutral in reaction to litmus, and it had a less marked odor than the black unsedimented water, but the characteristic tarry odor was still unmistakable. The conclusion is that the sample of water in question is readily fatal to ordinary fishes and fatal also, but somewhat less quickly, to hardy forms such as the cat-fish.

A representative of the Commission testified to the foregoing facts in court on summons issued by the government. The defendant was found guilty and sentenced—an appeal being taken.

DESTRUCTION OF YOUNG TROUT BY HYDRA.

At the Leadville, Colo., station of the Commission in the summer of 1902, many newly-hatched black-spotted trout were destroyed by an agent not previously met with, and the existence of which was not sus-

pected until a special examination of the water supply disclosed great numbers of a minute animal in the hatching troughs. Mr. A. E. Beardsley, professor of biology in the State Normal School at Greeley, Colo., was asked to visit the hatchery and look into the mortality among the fish; and his report[a] shows conclusively that the trouble was due to a species of hydra, which gained access to the hatchery from a shallow lake which is one of the sources of water supply. A careful investigation having failed to disclose any other cause for the death of trout, and the hydras being known to be armed with dart cells, which secrete a fluid by which small crustaceans and other animals are quickly paralyzed, the responsibility of the hydras was demonstrated by experimental tests. Newly-hatched fry were placed in beakers filled with water from the supply pipes with a little sediment from the hatching trough in which the hydras were found. In less than thirty minutes 25 per cent of the fry were dead, and in seventy-five minutes all were dead, while in a beaker filled with water containing no hydras all the fry were alive the next day. With the aid of a lens the hydras could be seen with their mouths closely applied to the surface of the fry, particularly on the yolk sac—a dozen hydras sometimes attaching themselves to a single fish. When first attacked the fish struggled violently, but the movements gradually diminished in frequency and intensity until death supervened.

This hatchery pest is to be overcome by excluding water from the lake containing hydra, and by scrubbing the troughs with a stiff brush and then quickly flushing them so as to wash out the hydras before they can become attached.

This particular hydra appears to represent an undescribed form, characterized by its large size and absence of color, and has been named *Hydra pallida* by Mr. Beardsley.

GAS DISEASE IN AQUARIUM FISH.

For a number of years the aquarium at the Woods Hole station has with great difficulty been kept stocked with fish and other animals, owing to their rapid death from what has come to be known as the gas or bubble disease. The condition of affairs having become more aggravated, it was necessary, in the interest of the fish-cultural work, as well as of the biological laboratory, to give the matter special attention. In the Bulletin for 1899 Prof. F. P. Gorham published a paper[b] which explained some of the phenomena, but was not applicable to all the manifestations of this affection; and it was therefore decided to reopen this subject, which, while not as yet of great practical importance, may at any time have a bearing on fish-cultural work and aquarium management. The following data on the symptoms and cause of the disease are embodied in a report submitted by Mr. M. C. Marsh,

[a] Destruction of Trout Fry by Hydra. Bulletin U. S. Fish Commission 1902, pp. 157-160.

[b] The Gas-bubble Disease of Fish and its Cause.

who visited the station in December and made a thorough examination of the water supply, pipes, pumps, tanks, aquarium, and fishes.

Under date of December 1, the superintendent had reported that fish could not be kept alive in the aquaria more than forty-eight hours, notwithstanding every possible attention and care. This accorded with the experience during the previous summer when, on account of the workers in the laboratory and the large numbers of visitors at the station, an effort was made to keep the aquaria well stocked. These aquaria are supplied with sea water from the same tanks that feed the hatchery, the tanks being kept full by two steam pumps which carry the water from the basin or pool in front of the hatchery.

Specimens of the common winter fishes available for the aquaria (white perch, tautog, tomcod, sculpins, and flat-fish), caught in a fyke net in the harbor and immediately transferred to the aquaria, in about three minutes became covered with minute bubbles of gas. These bubbles increased in number and, after ten minutes, thickly covered the fish, giving to dark species like the tomcod a silvery appearance. When a fish was removed from the water a moment the bubbles immediately dissipated, but were renewed, as before, when it was returned to the water. They constantly escaped in small numbers from the body and rose to the surface of the water, while a sudden movement on the part of the fish released a cloud of thousands of bubbles. After a short time, however, it was again covered with them, so that it was seldom without more or less of these gas bubbles clinging to any or all parts of the body and fins. After a period varying from three hours to several days, the fish died, usually with spasmodic convulsions. Of a lot of about 100 specimens, 70 per cent were dead after forty-eight hours, though a few flat-fish survived four days.

Dissection of the bodies showed a remarkable condition. The blood vascular system contained notable quantities of gas. In the mildest degree this appeared as large bubbles here and there in the larger vessels, which still contained blood. In the extreme cases the heart itself contained gas to the exclusion of the blood. The bulbus of the heart was often greatly distended—even to several times its normal bulk—its walls stretched to an attenuated thinness, tense and firm with the pressure of the contained gas to the entire exclusion of the blood, the whole resembling the air bladder of a small fish. The auricle sometimes continued beating, but without propelling any blood. Often the thick wall of the ventricle was emphysematous. The vessel from the heart to the gills was empty of blood, and in the gills was found perhaps the most constant and significant lesion. The main vessel of the gill filament was filled with gas, which was often seen just entering the capillaries that branch from this vessel. It seldom filled these capillaries, however. These gas plugs of the gill filaments were usually present, even when the evidences of gas within the body were

not very marked. When nearly all the filaments were well filled with gas the condition modified somewhat the microscopic appearance of the gill, and the individual emboli were seen on a careful inspection by the naked eye. Gas emboli were the usual immediate cause of death by asphyxiation.

On the exterior of the fish, besides the minute bubbles that appear almost immediately after immersion in the water, blebs appear after some lapse of time which are made by an accumulation of gas beneath the membranous portions of the epithelium. They may hold several centimeters of gas, and occur chiefly in the fins in nearly all species, also on the belly of the small sculpin, and rarely on the cornea. "Pop-eye" was not observed at this time.

The agent that produces this fatal evolution of gas is evidently present in the water and is introduced into it somewhere between the suction intake and the taps that deliver the water at the points where it is used—in aquaria and hatchery; for neither in the fyke net, 8 feet beneath the surface of the water in the harbor, nor in live boxes at the surface of the basin in close proximity to the intake, do fish die or exhibit any of the symptoms described. After this water has passed from the basin through the system of pipes, including the steam pump and the supply tanks, it possesses the power to produce such symptoms, ending invariably in the death of the fish. This pathologic agent is volatile, for if one of the large stationary aquaria be filled and allowed to stand for seven days with the flow cut off, the water has lost markedly its lethal power; it will produce external bubbles on fishes, but will not kill. About 2½ gallons of the freshly drawn water held in the cylindrical glass hatchery jars cease entirely to produce the external bubbles after standing from two to three days. In proportion as the water is exposed to the air it loses this quality, and an aeration apparatus which divides the water into fine streams immediately dissipates this power to such an extent that the fish do not die in it. Thus an aquarium that received several capillary jets spurting into it from a distance of several feet held its fish successfully, while the fish in a control aquarium which received the same amount of capillary flow, and which differed only in the fact that the capillary jets were submerged within the aquarium, died after one day. The agent evidently passes off into the air.

In the course of some aquarium experiments, using water directly from the pump, it became evident that the water passing through the pump constantly contained a considerable quantity of air in small bubbles. This air must have entered the suction area, and a wooden supply pipe between basin and pump, several feet beneath the ground, was subsequently found to leak in a number of places. The pressure of this air in the water suggests immediately an explanation which is in accord with all the facts observed. Water absorbs air in proportion

to the pressure, and cold water takes up more than warm water. The station water in winter approaches 0° C. The supply tanks are some 18 feet above the ground, and the water in the system of pipes leading from them is under corresponding pressure. Accordingly, any air accompanying the water in these pipes must constantly tend to pass into solution, and as the water when taken up from the basin is approximately saturated for atmospheric pressure the water in the pipes must tend to saturate with air for the increased pressure it sustains, or to supersaturate for atmospheric pressure.

In the hatchery and the aquaria the water emerges from the pipes into ordinary atmospheric pressure, containing in solution more air than it can hold at that pressure. The excess of air instantly begins to pass off, or evaporate, the rapidity of the process depending on a favorable exposure of the water to the air, and therefore on the conformation of the containing vessel, a very shallow open vessel facilitating the escape of air. The aquaria are not particularly adapted to this release, and the constant inflow from the pipes maintains the supersaturation of the volume of water in the aquarium to very nearly that of the water in the pipes.

The gill apparatus of fishes, for the osmotic interchange of gases which keeps the blood purified, is adjusted to water in which the gases are dissolved at atmospheric pressure. In this supersaturated aquarium water an extraordinarily high osmotic pressure exists at the gill membrane. On the inside of this membrane the blood stream tends toward a supersaturation equal to that of the water on the outside. Two chief factors are then conceived to operate to separate the air from solution, one being the temperature of the systemic blood, the other the mechanical effect of the surface of the vessels and of the corpuscles.

The oxidation which is constantly taking place within the blood must determine a higher temperature in the blood than in the water surrounding the fish. This has been shown by observation to be the fact for certain marine fishes, the difference in some cases amounting to several degrees. The blood must be cooled as it passes through the gills and receives its supply of air, and the subsequent elevation of temperature must cause some of the air to come out of solution and appear in the blood stream as free bubbles. In a liquid supersaturated with gas, contact with a solid surface causes some of the gas to deposit in bubbles on this surface. The vascular and corpuscular surfaces therefore probably add to the tendency of the gas to come out of solution. The process continues until the inevitable mechanical stoppage of the circulation occurs.

With the advent of the flat-fish season nearly ripe fish began to arrive at the station, to be held in wooden tanks until spawning occurred. The first lot of these fish, a small number, being in the station water, were killed by it like the aquarium fish, as was expected,

and before they had cast their spawn. Thus it appeared impossible to carry on the flat-fish work in this water. In order to hold these fish until the radical remedy of repairing the intake pipes could be applied, a simple apparatus was suggested for the speedy dissipation of the excess of dissolved air. The superintendent suspended high above the upper tank of each series of three a dish pan with the bottom perforated with many small holes. The water was piped up from the taps to these pans, entering them in several jets from a metal delivery head, the jets impinging against the side of the pan, to flow down through the perforations and drop several feet in a shower of separate streams to the surface of the water in the flat-fish tanks. This device, which could aerate water at all deficient in dissolved air, accomplishes a de-aeration for supersaturated water. The de-aerating process removed sufficient of the excess of air to hold the flat fish without loss, and flat-fish operations were carried on in this way during the season.

Plates made from the blood of the dead and dying fish indicate the absence of bacteria from the blood, and indeed the explanation given above, ascribing the mortality to purely physical causes, excludes bacteria from any part in it. Moreover, the immediate appearance of gas renders it practically impossible that it should be the product of a gas-producing organism, for the reaction occurs too quickly. It is evident that this particular epidemic or mortality is not an infection, and that contamination of the water is not related in any way to this disease of fishes.

The immunity of the cod fry and eggs from the gas disease is to be commented upon. These are incubated and hatched in the same station water that is fatal to adults of all species experimented with, including the adult cod. In no case have they been seen to exhibit the gaseous symptoms, and hatching operations have gone on as usual. The egg and the fry are of course very differently organized from the adult, their tissues are not yet so differentiated and specialized, and the gaseous interchange not to be compared, in degree at least, with that of the adult. Were the fry to be held for a time, it is to be expected that they would fall victims to the disease, but they are planted almost as soon as hatched.

Of any factors that readily occur to mind as playing a part in the immunity, that of temperature is probably the most important. The fry can scarcely be conceived to maintain a temperature appreciably above that of the surrounding water. There must be some combustion taking place, nevertheless, and theoretically there should be a difference in temperature. It is to be remembered, however, that it is not the difference in temperature between blood and water, but between the systemic blood and the gill blood that throws the gas from solution. The gill blood is cooled by its intimate contact with the water, and the

air is absorbed at this cooler temperature. In the fry the general and this special circulation may well be of the same temperature.

While it is possible to temporize with the present leaky pipes and obviate or greatly reduce the extent of the disease by providing for the de-aeration of the water, as before indicated, the only satisfactory way to overcome the difficulty is to replace the present old and evidently worn-out pipes by new ones which will permit the maintenance of an air-tight suction apparatus.

MARINE BIOLOGICAL LABORATORIES.

Woods Hole, Massachusetts (Dr. Hugh M. Smith, Director).

This laboratory was operated under the same general arrangements that prevailed in the previous year, with the usual facilities for collecting biological material and for supplying the needs of those occupying tables. The following persons, numbering forty-seven and representing twenty-four institutions, were in attendance; of these, seventeen were engaged in special investigations in the interests of the Fish Commission:

Adelbert College, Cleveland, Ohio: Prof. F. H. Herrick.

American Museum of Natural History, New York: Mr. Frank M. Chapman; Mr. J. D. Figgins; Mr. George H. Sherwood.

Brooklyn High School, Brooklyn, N. Y.: Mr. Fred Z. Lewis.

Brown University, Providence, R. I.: Prof. F. P. Gorham; Prof. R. W. Tower; Dr. Millett T. Thompson.

College of the City of New York: Mr. Frederick K. Morris; Mr. George G. Scott; Dr. Francis B. Sumner.

Clark University, Worcester, Mass.: Mr. Ernest S. Jones.

Columbia University, New York: Mr. Naohidé Yatsu.

Columbian University, Washington, D. C.: Miss Harriet Richardson.

Denison University, Granville, Ohio: Mr. I. A. Field; Prof. C. Judson Herrick.

Harvard University, Cambridge, Mass.: Mr. Robert S. Breed; Mr. Frederick W. Carpenter; Dr. W. E. Castle; Mr. Clarence W. Hahn; Dr. E. L. Mark; Dr. George H. Parker; Mr. A. W. Peters; Dr. Herbert W. Rand; Mr. Grant Smith; Mr. Frank E. Watson.

Johns Hopkins University, Baltimore, Md.: Mr. H. F. Perkins.

Massachusetts Institute of Technology, Boston, Mass.: Dr. Robert P. Bigelow.

McLean Hospital for the Insane, Waverly, Mass.: Dr. Otto Folin.

Northwestern University, Chicago, Ill.: Mr. Arthur D. Howard.

Olivet College, Olivet, Mich.: Prof. Hubert Lyman Clark; Mr. W. L. Sperry.

Princeton University, Princeton, N. J.: Mr. Joseph Caspar; Prof. Ulric Dahlgren; Mr. W. Phillips.

Rhode Island College, Kingston, R. I.: Mr. John Barlow.

State Normal School, Westfield, Mass.: Prof. Charles B. Wilson.

Syracuse University, Syracuse, N. Y.: Prof. Charles W. Hargitt; Mr. W. Martin Smallwood.

University of Texas, Austin, Tex.: Mr. Charles T. Brues.

United States Department of Agriculture, Washington, D. C.: Dr. Joseph S. Chamberlain; Mr. Karl F. Kellerman; Dr. George T. Moore; Dr. Rodney H. True.

Williams College, Williamstown, Mass.: Prof. James L. Kellogg.

Worcester High School, Worcester, Mass.: Mr. Myron W. Stickney.

Yale University, New Haven, Conn.: Dr. Wesley R. Coe.

Professor Tower, besides assisting in the administration of the laboratory affairs, continued his studies of the functions of the swim bladder in fishes. Professor Parker conducted a series of interesting and ingenious experiments as to the sense of hearing in fishes—a subject which has been much discussed and is not without its practical bearing on the fisheries. His report has been published in the Bulletin for 1902. Professor Herrick experimented on the sense of taste as developed in fishes, and submitted a very interesting report thereon, which was published as a part of the Bulletin for 1902. Doctor Sumner made some experimental studies of fish development, and also considered variation and eliminative selection in the killifish, *Fundulus majalis*. Mr. Field took up the question of the destructive powers of fishes having little or no food value.

The following were engaged in a systematic study of the groups indicated, having in view the preparation of special reports thereon pertaining to the Woods Hole region: Dr. Robert P. Bigelow, the crabs; Prof. Charles W. Hargitt, the medusæ; Miss Harriet Richardson, the isopods; Prof. H. L. Clark, the echinoderms; Prof. C. B. Wilson and Dr. M. T. Thompson, the copepods parasitic on fishes. The work of Professors Hargitt and Wilson was completed and their reports submitted; and Prof. S. J. Holmes, who had been engaged for several years in a study of the amphipods of the region, also completed his report.

BEAUFORT, NORTH CAROLINA (DR. CASWELL GRAVE, DIRECTOR).

The new laboratory buildings, which had been thrown open on May 26, 1902, were occupied until September 30. The laboratory proved to be admirably adapted in every way to the climate and to the special work intended to be carried on, and called forth unstinted praise from all who had an opportunity to occupy or visit the station. As in previous seasons, the launch *Petrel* was employed in making collections for the laboratory and in determining the aquatic resources of the sounds, the harbor, and the ocean in the vicinity of the entrance; it was not considered safe, however, to send the launch more than 5 miles from the mouth of the harbor. The *Fish Hawk* was attached to the laboratory during July, August, and September, and was employed in exploring the ocean floor as far as the Gulf Stream. The dredgings of the vessel showed a barren condition of most of the bottom, owing probably to the shifting character of the sand of which it is mainly composed. A conspicuous exception, however, was a bank or reef called locally "the fishing ground." It lies 20½ miles ssw. ¼ w. from the outer buoy on Beaufort bar, covered by 13½ fathoms of water, and has been known to the fishermen for some time, although their ideas of its size, location, and character are very indefinite. The exploration, measuring, and charting of this ground was the most important work done by the *Fish Hawk*, for this reasonably accessible locality will

doubtless provide much material for biological investigation and may also eventually support an important commercial fishery.

The ground is of a rough coralline nature, and contains a great abundance and variety of animal life. A 7-foot beam trawl and an oyster dredge brought up many specimens of fishes, crustaceans, mollusks, starfishes, immense holothurians, sea-fans, corals, and other animals characteristic of tropical coral reefs. The abundance of fish was surprising. While the vessel was drifting twice across the ground 15 hand lines were used, and 10 bushel basketfuls of fish, representing about 700 specimens, were caught. The time occupied in fishing was two hours. Most of the fish were sea bass, but a few red snappers, large red-mouthed grunts, and other species were taken. So long as the vessel was over the ground the fishes were caught as fast as the lines could be hauled in, rebated, and cast, but the moment the vessel drifted over the edge of the reef no more fish were caught.

Those who availed themselves of the privileges of the laboratory numbered seventeen, and were as follows, arranged under the institutions with which they were connected:

Johns Hopkins University: Prof. W. K. Brooks, Dr. Caswell Grave, Mr. R. E. Coker, Mr. R. P. Cowles, Mr. O. C. Glaser, Mr. E. W. Gudger, Mr. C. W. Stone, Mr. D. H. Tennant.

University of North Carolina: Mr. C. A. Shore, Mr. I. F. Lewis, Mr. F. M. Hanes.

Columbia University: Prof. E. B. Wilson, Mr. W. S. Sutton.

Washington and Jefferson College: Prof. Edwin Linton.

Trinity College, North Carolina: Prof. J. I. Hamaker.

Western Reserve University: Dr. F. C. Waite.

University of Pennsylvania: Prof. E. G. Conklin.

Professor Brooks was engaged in a study of the early stages of the development of the oyster egg and in rearing oyster larvæ up to the point where they become fixed. Mr. Glaser continued the experimental oyster planting in Newport and North rivers. Mr. Tennant resumed his work on the life history of the oyster parasite, *Bucephalus*. Professor Linton had under consideration the parasites of the fishes of the Beaufort region. Mr. Coker made observations on the diamond-back terrapin, and studied the development of the ship-worm. The habits, structure, and development of the stone crab were studied by Mr. Shore. This is one of the best of the crabs for food, but in the Beaufort region it is not sufficiently abundant to be of importance commercially. Professor Conklin and Professor Wilson carried on experimental studies of the eggs of various invertebrates. Mr. Gudger gave attention to the development of the pipe-fish. Doctor Hamaker continued his work on the actinians of the Beaufort region, having in view a complete account of the biology of each species.

REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES.

By Barton W. Evermann, *Assistant in Charge.*

At the beginning of the year the statistical agents of the division were engaged in canvassing the fisheries of the Middle Atlantic States. This work was completed, and a report on the fisheries of that region, which has since been issued, was prepared for publication. In the meantime a summary of the statistics embodied in the report was published as Statistical Bulletin No. 131.

Mr. F. F. Dimick and Capt. S. J. Martin, local statistical agents of the Commission at Boston and Gloucester, Mass., respectively, have continued to submit during the year their usual monthly returns of the quantity and value of fishery products landed at those ports by American fishing vessels.

Mr. A. B. Alexander, fishery expert of the steamer *Albatross*, was detailed in November, 1902, to Boston, Mass., to obtain statistics of the quantity and value of mackerel landed by the New England fleet during that year. In March, 1903, Mr. Alexander visited Seattle, Wash., and entered upon a statistical canvass of the salmon fisheries of Alaska for the seasons of 1901 and 1902. He was authorized to pursue the inquiry in such places on Puget Sound and the Columbia River as might be necessary to obtain the desired information. In June he joined the steamer *Albatross* at Seattle and went to Alaska as a member of the Alaska Salmon Commission under the direction of Dr. David S. Jordan, where the investigation was continued.

The fisheries of Porto Rico, including the wholesale fishery trade and the importation of fishery products, were investigated in January, February, and March, 1903, by Mr. W. A. Wilcox, the data being chiefly for the year 1902.

Mr. Charles H. Stevenson visited New York for a short time in March, 1903, for the purpose of obtaining information concerning the utilization of ivory, bones, shells, scales, etc., of aquatic animals.

An investigation of the fisheries of the South Atlantic and Gulf States was undertaken in February, 1903, the data being for the calendar year 1902, except the oyster fishery, for which it was necessary in some instances to obtain statistics for the last completed oyster

season. In connection with this inquiry Mr. John N. Cobb was assigned to canvass Florida and that part of North Carolina north of Beaufort and Hyde counties; Mr. Charles H. Stevenson, Louisiana, Texas, and the remainder of North Carolina south of Washington and Tyrrell counties; Mr. W. A. Roberts, Mississippi and Alabama; Messrs. W. A. Wilcox and T. M. Cogswell, South Carolina and Georgia. Except in part of the territory in North Carolina, the work was finished before the close of the fiscal year.

The salmon fisheries of Penobscot River and Bay for the year 1902 were investigated by Mr. Charles G. Atkins, superintendent of the United States Fish Commission station at Craig Brook, Me. A canvass of these fisheries, begun by Mr. Atkins the previous year for 1900 and 1901, was also completed.

The investigation of the fisheries of Colorado by Mr. E. A. Tulian, superintendent of the United States Fish Commission station at Leadville, Colo., was concluded, the data being for the year 1900. This work was authorized in connection with a canvass of the fisheries of Nevada and Utah, the results of which have already been published.

The publications prepared in this division and distributed during the year included statistical bulletins, issued as single sheets, and special reports on important fishery subjects. The following, exclusive of the usual monthly bulletins in single sheets showing the quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels, is a list of these publications:

Statistical Bulletin No. 130. Statement of the quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1902.

Statistical Bulletin No. 131. Fisheries of the Middle Atlantic States, 1901.

The sponge fishery of Florida in 1900, by J. N. Cobb. <Report for 1902, pp. 161–175, plates 6–9. 1903.

Aquatic products in arts and industries, by C. H. Stevenson. <Report for 1902, pp. 177–279, plates 10–25. 1903.

The utilization of the skins of aquatic animals, by C. H. Stevenson. <Report for 1902, pp. 281–352, plates 26–38. 1903.

The fisheries and fish trade of Porto Rico, by W. A. Wilcox. <Report for 1902, pp. 367–395. 1903.

VESSEL FISHERIES OF BOSTON AND GLOUCESTER.

The quantity of fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1902, as indicated by the returns received from the local agents at those ports, was 7,334 fares, which aggregated 167,954,875 pounds of fresh and salted fish, having a value to the fishermen of $4,379,082. This is an increase, as compared with the previous year, of 370 fares, and of 16,789,684 pounds in the quantity and $129,081 in the value of the products. In the quantity and value of fish landed at Boston there was an increase

of 578 fares, 19,981,865 pounds, and $467,188; and at Gloucester a decrease of 208 fares, 3,192,181 pounds, and $338,107.

The total number of fares landed at Boston was 3,981, and the products comprised 77,608,596 pounds of fresh fish, valued at $1,994,198, and 1,365,400 pounds of salted fish, valued at $48,440; a total of 78,973,996 pounds, valued at $2,042,638. From the eastern banks there were 212 fares, amounting to 10,847,560 pounds, $347,018, and from the banks off the New England coast 3,769 fares, with 68,126,436 pounds, $1,695,620.

At Gloucester 3,353 fares were landed, having 39,614,878 pounds of fresh fish, valued at $787,676, and 49,366,001 pounds of salted fish, valued at $1,548,768; a total of 88,980,879 pounds, valued at $2,336,444. Of this quantity 585 fares with 52,084,789 pounds of fresh and salted fish, valued at $1,347,241, were from the eastern banks, and 2,768 fares with 36,896,090 pounds, valued at $989,203, were from the banks off the New England coast.

Summary, by fishing-grounds, of certain fishery products landed at Boston, Mass., in 1902 by American fishing vessels.

Fishing-grounds.	No. of trips.	Cod.				Cusk.	
		Fresh.		Salted.		Fresh.	
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:							
La Have Bank	71	1,402,500	$35,490			225,200	$3,399
Western Bank	42	1,185,000	30,568			13,300	215
Quereau Bank	14	175,000	2,750				
Green Bank	2	20,000	500				
Grand Bank	16	18,000	360				
St. Peters Bank	3						
Off Newfoundland	24			10,000	$200		
Cape Shore	30	583,500	16,063			31,000	605
Gulf of St. Lawrence	10	1,000	20				
Total	212	3,385,000	85,751	10,000	200	269,500	4,219
West of 66° W. longitude:							
Browns Bank	36	597,900	15,137			115,000	1,661
Georges Bank	590	5,270,000	132,094			192,665	3,216
Cashes Bank	42	208,200	6,266			86,000	1,361
Clark Bank	7	36,500	983			4,000	44
Fippenies Bank	9	54,000	1,255			11,000	276
Tillies Bank	4	9,500	360			1,200	48
Middle Bank	235	428,300	11,904			38,000	843
Platts Bank	1	4,000	80				
Jeffreys Ledge	299	651,400	18,067			77,400	1,395
South Channel	642	5,354,700	121,604			103,500	1,534
Nantucket Shoals	142	2,158,500	34,361			700	10
Off Highland Light	52	124,300	3,970			10,200	371
Off Chatham	87	355,100	9,512			18,000	257
Shore, general	1,623	4,596,500	130,071			196,800	3,037
Total	3,769	19,848,900	485,664			854,465	14,053
Grand total	3,981	23,233,900	571,415	10,000	200	1,123,965	18,272

Summary, by fishing-grounds, of certain fishery products landed at Boston, Mass., in 1902 by American fishing vessels—Continued.

Fishing-grounds.	Haddock, fresh.		Hake, fresh.		Pollock, fresh.		Halibut, fresh.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank	1,517,500	$32,938	248,000	$3,668	62,500	$1,096	74,260	$6,134
Western Bank	140,500	3,533	118,000	1,585	24,000	585	361,900	29,695
Quereau Bank							293,000	23,370
Green Bank	20,000	600	35,000	495			45,000	2,100
Grand Bank							369,000	25,770
St. Peters Bank							67,000	4,470
Off Newfoundland							513,000	27,500
Cape Shore	453,500	11,835	93,000	1,500	40,000	759	2,900	312
Gulf of St. Lawrence							377,000	20,970
Total	2,131,500	48,906	494,000	7,248	126,500	2,440	2,103,060	140,321
West of 66° W. longitude:								
Browns Bank	741,300	17,855	67,000	1,325	54,500	778	8,500	993
Georges Bank	9,240,100	185,258	672,000	13,814	364,500	5,287	80,750	7,243
Cashes Bank	154,800	5,515	367,500	7,117	56,500	750	1,800	192
Clark Bank	76,500	1,730	48,000	500	1,000	5		
Fippenies Bank	50,400	910	27,000	707	4,500	113	400	40
Tillies Bank	25,000	885	1,000	23	1,500	60		
Middle Bank	1,502,800	37,391	257,000	5,347	220,000	3,553	300	30
Platts Bank					2,000	20		
Jeffreys Ledge	1,504,300	41,803	651,000	10,990	591,900	9,130	1,500	121
South Channel	11,323,900	263,064	4,067,400	66,173	629,900	7,648	24,350	1,801
Nantucket Shoals	355,200	6,380	25,000	286	197,150	2,187	2,500	200
Off Highland Light	426,500	11,468	80,500	1,122	52,500	889		
Off Chatham	1,287,800	29,509	151,500	2,371	129,600	1,999	1,000	120
Shore, general	5,318,750	130,425	1,314,950	24,581	944,813	14,472	34,660	2,868
Total	32,007,350	732,193	7,729,850	134,356	3,250,363	46,891	155,760	13,608
Grand total	34,138,850	781,099	8,223,850	141,604	3,376,863	49,331	2,258,820	153,929

Fishing-grounds.	Mackerel.				Other fish.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank					1,600	$184		
Off Newfoundland					1,571,000	44,715	710,000	$10,680
Cape Shore			45,000	$2,306	400	48		
Total			45,000	2,306	1,573,000	44,947	710,000	10,680
West of 66° W. longitude:								
Georges Bank	1,292,025	$86,761	247,600	12,882	1,062,000	82,443		
Cashes Bank	2,250	225						
Fippenies Bank					600	90		
Middle Bank	147,000	8,535	12,000	675	600	48		
South Channel	60,750	4,050	14,000	744	4,200	346		
Nantucket Shoals					5,200	448		
Off Chatham					600	36		
Shore, general	593,973	41,226	326,800	20,953	510,150	9,393		
Total	2,095,998	140,797	600,400	35,254	1,583,350	92,804		
Grand total	2,095,998	140,797	645,400	37,560	3,156,350	137,751	710,000	10,680

Summary, by fishing-grounds, of certain fishery products landed at Boston, Mass., in 1902 by American fishing vessels—Continued.

Fishing-grounds.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:						
La Have Bank	3,531,560	$82,909			3,531,560	$82,909
Western Bank	1,842,700	66,181			1,842,700	66,181
Quereau Bank	468,000	26,120			468,000	26,120
Green Bank	120,000	3,695			120,000	3,695
Grand Bank	387,000	26,130			387,000	26,130
St. Peters Bank	67,000	4,470			67,000	4,470
Off Newfoundland	2,084,000	72,215	720,000	$10,880	2,804,000	83,095
Cape Shore	1,204,300	31,122	45,000	2,306	1,249,300	33,428
Gulf of St. Lawrence	378,000	20,990			378,000	20,990
Total	10,082,560	333,832	765,000	13,186	10,847,560	347,018
West of 66° W. longitude:						
Browns Bank	1,584,200	37,749			1,584,200	37,749
Georges Bank	18,174,040	516,116	247,600	12,882	18,421,640	528,998
Cashes Bank	877,050	21,426			877,050	21,426
Clark Bank	166,000	3,262			166,000	3,262
Fippenies Bank	147,900	3,391			147,900	3,391
Tillies Bank	38,200	1,376			38,200	1,376
Middle Bank	2,594,000	67,651	12,000	675	2,606,000	68,326
Platts Bank	6,000	100			6,000	100
Jeffreys Ledge	3,477,500	81,506			3,477,500	81,506
South Channel	21,568,700	466,220	14,000	744	21,582,700	466,964
Nantucket Shoals	2,744,250	43,872			2,744,250	43,872
Off Highland Light	694,000	17,820			694,000	17,820
Off Chatham	1,943,600	43,804			1,943,600	43,804
Shore, general	13,510,596	356,073	326,800	20,953	13,837,396	377,026
Total	67,526,036	1,660,366	600,400	35,254	68,126,436	1,695,620
Grand total	77,608,596	1,994,198	1,365,400	48,440	78,973,996	2,042,638

Summary, by fishing-grounds, of certain fishery products landed at Gloucester, Mass., in 1902 by American fishing vessels.

Fishing-grounds.	No. of trips.	Cod.				Cusk.			
		Fresh.		Salted.		Fresh.		Salted.	
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. long.:									
La Have Bank	77	2,141,120	$35,943	377,000	$12,968	129,000	$1,539		
Western Bank	49	1,825,270	32,087	775,560	25,407	56,000	682		
Quereau Bank	207	5,490,205	81,659	8,583,967	248,215	70,000	830	13,000	$243
Green Bank	1			4,000	150				
Grand Bank	64	59,080	1,037	11,006,560	269,284				
St. Peters Bank	5			46,840	1,624				
Bacalieu Bank	37			70,235	2,167				
Off Newfoundland	76	14,000	189	177,722	4,717				
Cape North	1			180,000	3,800				
Cape Shore	55	314,360	5,900	75,000	2,438	128,460	285		
Gulf of St. Lawrence	13	70,000	840	115,068	3,532				
Total	585	9,914,035	157,655	21,411,952	574,302	383,460	3,336	13,000	243
West of 66° W. long.:									
Browns Bank	40	721,132	10,375	124,740	3,855	59,340	705	3,000	75
Georges Bank	458	863,582	17,498	8,676,569	286,169	4,000	52	5,000	113
Cashes Bank	11	83,860	1,357			59,040	758		
Ipswich Bay	13	9,000	159						
South Channel	38	239,000	3,980	25,000	626	12,000	146		
Off Chatham	2								
Bay of Fundy	6	60,000	943			100,000	1,151		
Shore, general	2,200	1,248,807	31,932			42,700	564		
Total	2,768	3,225,381	66,244	8,826,309	290,650	277,080	3,376	8,000	188
Grand total	3,353	13,139,416	223,899	30,238,261	864,952	660,540	6,712	21,000	431

Summary, by fishing-grounds, of certain fishery products, etc.—Continued.

Fishing grounds.	Haddock.				Hake.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. long.:								
La Have Bank	365,280	$6,303			2,648,500	$24,374		
Western Bank	164,120	3,561			222,000	2,096		
Quereau Bank	155,931	2,147			197,000	1,646	85,000	$1,063
Grand Bank	191,626	2,935						
Off Newfoundland					40,000	320		
Cape Shore	92,240	2,083			30,000	300	3,000	68
Total	969,197	17,029			3,137,500	28,736	88,000	1,131
West of 66° W. long.:								
Browns Bank	783,550	6,142	2,000	$40	178,620	1,574	1,000	23
Georges Bank	1,666,255	24,641			10,000	148		
Cashes Bank	70,120	690			170,000	1,692		
South Channel	358,000	2,505			194,500	2,209		
Bay of Fundy	10,000	80			248,180	2,075		
Shore, general	399,342	6,377			2,100,872	28,518	45,000	1,238
Total	3,287,267	40,435	2,000	40	2,902,172	36,216	46,000	1,261
Grand total	4,256,464	57,464	2,000	40	6,039,672	64,952	134,000	2,392

Fishing grounds.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. long.:								
La Have Bank	9,000	$64			39,125	$3,734		
Western Bank	4,000	32			151,679	11,494		
Quereau Bank					1,197,695	101,969	22,400	$1,612
Green Bank					27,899	2,411		
Grand Bank					244,248	18,418	15,600	1,255
St. Peters Bank					24,948	2,187	4,000	360
Bacalieu Bank					996,800	53,394	693,500	46,801
Off Newfoundland					576,570	43,555	17,240	1,409
Cape Shore	12,000	82	10,000	$125				
Gulf of St. Lawrence					382,067	18,789		
Total	25,000	178	10,000	125	3,641,031	255,951	752,740	51,437
West of 66° W. long.:								
Browns Bank					70,352	1,848		
Georges Bank	250	4	6,000	90	356,234	25,534		
Ipswich Bay	109,500	592						
Off Chatham	35,000	263						
Bay of Fundy					250	25		
Shore, general	9,032,975	68,119						
Total	9,177,725	68,978	6,000	90	426,836	27,407		
Grand total	9,202,725	69,156	16,000	215	4,067,867	283,358	752,740	51,437

Fishing grounds.	Mackerel.				Other fish.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. long.:								
Quereau Bank					5,574	$669		
Off Newfoundland					1,066,500	33,953	9,313,000	$142,363
Cape Shore			1,353,800	$80,133				
Total			1,353,800	80,133	1,072,074	34,622	9,313,000	142,363
West of 66° W. long.:								
Georges Bank	368,100	$19,985	3,685,200	191,948	17,250	1,705		
South Channel	18,000	900			5,800	560		
Off Chatham					27,000	90		
Shore, general	290,070	18,419	2,454,600	191,829	449,900	5,854	1,395,400	23,028
Total	676,170	39,304	6,139,800	383,777	499,950	8,209	1,395,400	23,028
Grand total	676,170	39,304	7,493,600	463,910	1,572,024	42,831	10,708,400	165,391

Summary, by fishing-grounds, of certain fishery products, etc.—Continued.

Fishing grounds.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. long.:						
La Have Bank	5,332,025	$71,957	377,000	$12,968	5,709,025	$84,925
Western Bank	2,423,069	49,952	775,560	25,407	3,198,629	75,359
Quereau Bank	7,116,405	188,920	8,704,367	251,133	15,820,772	440,053
Green Bank	27,899	2,411	4,000	150	31,899	2,561
Grand Bank	494,954	22,390	11,022,160	270,539	11,517,114	292,929
St. Peters Bank	24,948	2,187	50,840	1,984	75,788	4,171
Bacalieu Bank	996,800	53,394	763,735	48,968	1,760,535	102,362
Off Newfoundland	1,697,070	78,017	9,507,962	148,489	11,205,032	226,506
Cape North			180,000	3,800	180,000	3,800
Cape Shore	577,060	8,650	1,441,800	82,764	2,018,860	91,414
Gulf of St. Lawrence	452,067	19,629	115,068	3,532	567,135	23,161
Total	19,142,297	497,507	32,942,492	849,734	52,084,789	1,347,241
West of 66° W. long.:						
Browns Bank	1,812,994	20,644	130,740	3,993	1,943,734	24,637
Georges Bank	3,285,671	89,567	12,372,769	478,320	15,658,440	567,887
Cashes Bank	383,020	4,497			383,020	4,497
Ipswich Bay	118,500	751			118,500	751
South Channel	827,300	10,300	25,000	626	852,300	10,926
Off Chatham	62,000	353			62,000	353
Bay of Fundy	418,430	4,274			418,430	4,274
Shore, general	13,564,666	159,783	3,895,000	216,095	17,459,666	375,878
Total	20,472,581	290,169	16,423,509	699,034	36,896,090	989,203
Grand total	39,614,878	787,676	49,366,001	1,548,768	88,980,879	2,336,444

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1902.

Months.	No. of trips.	Cod.				Cusk.			
		Fresh.		Salted.		Fresh.		Salted.	
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	389	1,584,700	$46,541			128,600	$2,462		
February	286	1,068,100	42,570			32,700	798		
March	425	2,700,400	66,688			59,500	1,257		
April	418	1,536,900	29,358			121,500	1,728		
May	295	1,940,600	33,464			169,500	2,037		
June	251	1,438,400	43,357			49,900	932		
July	361	2,999,300	48,662			49,000	585		
August	359	2,786,900	41,273	10,000	$200	10,000	150		
September	304	2,317,600	52,690			75,465	1,003		
October	320	2,305,800	79,961			155,200	2,564		
November	304	1,656,200	48,446			141,800	2,067		
December	269	899,000	38,405			130,800	2,689		
Total landed at Boston	3,981	23,233,900	571,415	10,000	200	1,123,965	18,272		
January	163	366,285	11,279	429,660	16,127	5,000	75		
February	153	292,250	11,816	203,455	7,704	9,400	181		
March	220	1,824,347	29,005	399,704	14,533				
April	254	1,996,102	27,726	579,055	16,741	136,180	1,593		
May	262	1,875,377	26,011	2,814,110	75,656	196,260	1,063	8,000	$138
June	248	406,305	5,581	3,160,137	71,942	27,000	311		
July	323	959,000	14,240	7,412,155	162,510	128,000	1,478		
August	194	1,456,800	20,629	1,512,000	40,816	32,000	384		
September	373	1,837,000	31,097	3,250,000	101,954	66,000	835	8,000	180
October	320	718,500	13,344	2,888,485	95,194	50,200	653	5,000	113
November	538	1,071,600	22,037	6,740,500	229,638	8,500	111		
December	305	335,850	11,134	849,000	32,137	2,000	30		
Total landed at Gloucester	3,353	13,139,416	223,899	30,238,261	864,952	660,540	6,712	21,000	431
Grand total	7,334	36,373,316	795,314	30,248,261	865,152	1,784,505	24,984	21,000	431
Grounds E. of 66° W. long	797	13,299,035	243,406	21,421,952	574,502	652,960	7,555	13,000	243
Grounds W. of 66° W. long	6,537	23,074,281	551,908	8,826,309	290,650	1,131,545	17,429	8,000	188
Landed at Boston in 1901	3,403	16,892,450	469,544	16,000	420	1,090,300	17,547		
Landed at Gloucester in 1901	3,561	19,080,074	380,154	29,702,801	973,974	938,618	14,422	51,980	1,377

Statement, by months, of quantities and values of certain fishery products, etc.—Cont'd.

Months.	Haddock.				Hake.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	3,682,400	$85,849	....	....	687,500	$15,887	....	....
February	3,669,700	92,115	....	....	140,900	4,749	....	....
March	5,070,000	91,030	....	....	152,600	7,102	....	....
April	2,983,000	43,546	....	....	195,500	2,474	....	....
May	1,925,200	51,341	....	....	333,500	3,811	....	....
June	1,900,900	45,437	....	....	595,000	8,125	....	....
July	2,827,800	46,759	....	....	413,800	5,420	....	....
August	2,705,150	49,625	....	....	777,600	8,465	....	....
September	2,935,700	68,209	....	....	895,800	14,457	....	....
October	3,231,700	96,595	....	....	1,487,500	26,854	....	....
November	2,119,400	63,316	....	....	1,791,000	25,627	....	....
December	1,087,900	47,277	....	....	753,150	18,633	....	....
Total landed at Boston	34,138,850	781,099	....	....	8,223,850	141,604	....	....
January	409,515	9,229	....	....	41,090	745	....	....
February	679,983	13,970	....	....	16,000	380	....	....
March	991,648	13,345	....	....	....	....	....	....
April	1,128,630	8,083	....	....	164,000	1,514	....	....
May	109,298	826	2,000	$40	187,120	1,587	76,000	$961
June	61,390	399	....	....	1,011,362	8,168	3,000	68
July	341,000	2,145	....	....	1,511,000	12,617	....	....
August	105,800	800	....	....	264,000	2,112	....	....
September	95,000	710	....	....	532,000	6,288	55,000	1,363
October	15,200	228	....	....	1,517,500	20,454	....	....
November	204,600	4,364	....	....	655,000	9,150	....	....
December	114,400	3,365	....	....	140,600	1,937	....	....
Total landed at Gloucester	4,256,464	57,464	2,000	40	6,039,672	64,952	134,000	2,392
Grand total	38,395,314	838,563	2,000	40	14,263,522	206,556	134,000	2,392
Grounds E. of 66° W. long	3,100,697	65,935	....	....	3,631,500	35,984	88,000	1,131
Grounds W. of 66° W. long	35,294,617	772,628	2,000	40	10,632,022	170,572	46,000	1,261
Landed at Boston in 1901	24,731,350	618,235	....	....	7,457,850	117,327	....	....
Landed at Gloucester in 1901	4,198,891	71,089	45,970	827	3,663,097	40,119	148,480	2,270

Months.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	198,900	$4,697	....	....	178,700	$15,479	....	....
February	89,000	2,998	....	....	129,600	11,220	....	....
March	35,800	993	....	....	150,700	12,140	....	....
April	8,500	235	....	....	206,510	14,492	....	....
May	29,300	291	....	....	354,500	17,950	....	....
June	189,100	2,014	....	....	160,200	14,511	....	....
July	309,400	2,653	....	....	252,860	15,699	....	....
August	380,563	3,654	....	....	407,450	20,423	....	....
September	347,300	5,453	....	....	134,800	9,418	....	....
October	601,800	9,023	....	....	114,900	8,679	....	....
November	839,200	8,933	....	....	166,200	13,658	....	....
December	348,000	8,387	....	....	2,400	260	....	....
Total landed at Boston	3,376,863	49,331	....	....	2,258,820	153,929	....	....
January	17,810	204	....	....	152,670	14,928	6,950	$556
February	11,465	191	....	....	255,915	23,355	2,500	225
March	2,630	26	....	....	404,594	30,475	7,000	630
April	....	....	....	....	362,703	27,930	11,240	899
May	46,000	413	....	....	602,514	30,424	....	....
June	196,150	1,089	....	....	483,022	43,029	4,450	356
July	45,500	204	....	....	586,093	32,005	21,300	1,704
August	4,000	32	....	....	443,245	21,217	14,300	931
September	51,000	468	....	....	397,243	22,741	680,000	45,811

Statement, by months, of quantities and values of certain fishery products, etc.—Cont'd.

Months.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
October	1,207,000	$11,372	6,000	$90	209,713	$22,159	5,000	$325
November	6,594,800	45,903	10,000	125	106,655	8,730		
December	1,026,370	9,254			63,500	6,365		
Total landed at Gloucester	9,202,725	69,156	16,000	215	4,067,867	283,358	752,740	51,437
Grand total	12,579,588	118,487	16,000	215	6,326,687	437,287	752,740	51,437
Grounds E. of 66° W. long	151,500	2,618	10,000	125	5,744,091	396,272	752,740	51,437
Grounds W. of 66° W. long	12,428,088	115,869	6,000	90	582,596	41,015		
Landed at Boston in 1901	2,193,800	29,682			1,421,716	113,969		
Landed at Gloucester in 1901	5,151,140	38,614	97,742	1,247	3,643,455	286,033	462,590	41,051

Months.	Mackerel.				Other fish.[a]			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January					620,000	$16,500	350,000	$5,280
February					326,000	8,965		
March					550,000	17,000		
April								
May	21,600	$1,728	52,000	$2,600				
June	274,125	12,403	78,000	4,041	900	6		
July	1,169,575	77,937	233,400	12,149	436,900	30,851		
August	360,500	23,425	60,800	3,901	563,700	44,795		
September	267,675	25,057	218,200	14,614	136,000	11,633		
October	2,523	247	3,000	255	261,050	2,943		
November					145,550	1,818		
December					116,250	3,240	360,000	5,400
Total landed at Boston	2,095,998	140,797	645,400	37,560	3,156,350	137,751	710,000	10,680
January					396,000	12,400	1,236,000	18,540
February					70,200	2,145	92,000	1,832
March					420,300	13,408	135,000	2,488
April								
May	6,300	385	375,400	18,582				
June	113,360	6,059	1,643,500	84,630	27,000	90		
July	253,080	13,357	3,054,200	157,341	99,820	725		
August	193,950	11,221	832,700	49,590	12,200	340		
September	91,270	6,457	945,200	85,611	31,134	1,089	44,200	960
October	18,210	1,825	436,200	45,399	191,370	4,234	798,000	12,436
November			206,400	22,757	144,000	2,400	1,143,200	20,323
December					180,000	6,000	7,260,000	108,812
Total landed at Gloucester	676,170	39,304	7,493,600	463,910	1,572,024	42,831	10,708,400	165,391
Grand total	2,772,168	180,101	8,139,000	501,470	4,728,374	180,582	11,418,400	176,071
Grounds E. of 66° W. long			1,398,800	82,439	2,645,074	79,569	10,023,000	153,043
Grounds W. of 66° W. long	2,772,168	180,101	6,740,200	419,031	2,083,300	101,013	1,395,400	23,028
Landed at Boston in 1901	1,792,355	87,073	632,820	27,188	1,275,290	71,135	1,488,200	23,330
Landed at Gloucester in 1901	990,440	41,474	11,380,600	557,365	1,918,462	61,414	10,698,720	163,121

[a] Includes herring from Newfoundland, 2,637,500 pounds frozen, $78,668, and 10,023,000 pounds salted, $153,043.

Statement, by months, of quantities and values of certain fishery products, etc.—Continued.

Months.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	7,080,800	$187,415	350,000	$5,280	7,430,800	$192,695
February	5,456,000	163,415			5,456,000	163,415
March	8,719,000	196,210			8,719,000	196,210
April	5,051,910	91,833			5,051,910	91,833
May	4,774,200	110,622	52,000	2,600	4,826,200	113,222
June	4,608,525	126,785	78,000	4,041	4,686,525	130,826
July	8,458,635	228,566	233,400	12,149	8,692,035	240,715
August	7,991,863	191,810	70,800	4,101	8,062,663	195,911
September	7,110,340	187,920	218,200	14,614	7,328,540	202,534
October	8,160,473	226,866	3,000	255	8,163,473	227,121
November	6,859,350	163,865			6,859,350	163,865
December	3,337,500	118,891	360,000	5,400	3,697,500	124,291
Total landed at Boston	77,608,596	1,994,198	1,365,400	48,440	78,973,996	2,042,638
January	1,388,370	48,860	1,672,610	35,223	3,060,980	84,083
February	1,335,213	52,038	297,955	9,761	1,633,168	61,799
March	3,643,519	86,259	541,704	17,651	4,185,223	103,910
April	3,787,615	66,846	590,295	17,640	4,377,910	84,486
May	3,022,869	60,709	3,275,510	95,377	6,298,379	156,086
June	2,325,589	64,726	4,811,087	156,996	7,136,676	221,722
July	3,923,493	76,771	10,487,655	321,555	14,411,148	398,326
August	2,511,995	56,735	2,359,000	91,337	4,870,995	148,072
September	3,100,647	69,683	4,982,400	235,879	8,083,047	305,562
October	3,927,693	74,269	4,138,685	153,557	8,066,378	227,826
November	8,785,155	92,695	8,100,100	272,843	16,885,255	365,538
December	1,862,720	38,085	8,109,000	140,949	9,971,720	179,034
Total landed at Gloucester	39,614,878	787,676	49,366,001	1,548,768	88,980,879	2,336,444
Grand total	117,223,474	2,781,874	50,731,401	1,597,208	167,954,875	4,379,082
Grounds E. of 66° W. long	29,224,857	831,339	33,707,492	862,920	62,932,349	1,694,259
Grounds W. of 66° W. long	87,998,617	1,950,535	17,023,909	734,288	105,022,526	2,684,823
Landed at Boston in 1901	56,855,111	1,524,512	2,137,020	50,938	58,992,131	1,575,450
Landed at Gloucester in 1901	39,584,177	933,319	52,588,883	1,741,232	92,173,060	2,674,551

THE SALMON FISHERY OF PENOBSCOT RIVER AND BAY.

The results of the investigation of the salmon fishery of Penobscot River and Bay, by Mr. Charles G. Atkins, are here presented for the years 1900 and 1901, together with notes on certain fishes. The statistics of the salmon fishery for 1902 will be published at a later date in connection with the returns on the fisheries of Maine collected for that year by the field force of this division.

The salmon fishery of Penobscot River and Bay is located mainly in the river, but extends along the shores of the bay to Brooksville on the eastern side, to Lincolnville on the western side, and to Islesboro in the central bay. A few salmon were also taken at Criehaven, or Ragged Island, in 1901 and some earlier years, in connection with the fisheries for herring and other species. In the river the salmon are taken in weirs, and with set and drift gill nets, and in the bay they are caught chiefly in trap nets. The weirs have a leader and one or more floored pounds supported by stakes driven firmly in the ground. The leaders and the walls of the pounds are usually constructed of twine or wire

netting. The trap nets are also set with a leader, at the extreme end of which are two pounds, the "outer" and "inner" pounds, in which the salmon are captured. The trap nets are of twine netting supported by floats, rising and falling with the tide, and are held in place by long warps and anchors. The set and drift gill nets are each from 100 to 200 feet in length, and the size of the mesh is from 6 to 7 inches stretched. In the methods and location of this fishery there has been comparatively little change during the past thirty years.

The following table shows the extent of the salmon fishery of Penobscot River and Bay in 1900 and 1901:

Extent of the salmon fishery of Penobscot River and Bay in 1900 and 1901.

Towns.	Persons employed.		Weirs and traps.				Gill nets.			
			1900.		1901.		1900.		1901.	
	1900.	1901.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Brooksville (Cape Rosier)	1	1	2	$270	2	$270				
Bucksport	7	5	11	511	9	420				
Castine	2	2	2	200	2	210				
Hampden	2	2					3	$45	4	$60
Islesboro	2	4	6	280	8	360				
Lincolnville	5	6	11	495	14	558				
Ragged Island	2	2	1	800	1	800				
Northport	4	4	15	870	12	700				
Orland	13	15	14	544	16	576				
Orrington	4	5	1	54	1	54	11	120	15	225
Penobscot	13	12	20	1,260	17	1,122				
Searsport	2	2	3	540	3	540				
South Brewer	1	1					1	15	1	15
Stockton and Prospect	14	15	17	1,094	17	1,094				
Verona	13	14	30	2,500	32	2,610				
Winterport	2	3	2	175	2	175			1	15
Bangor	1	1					1	15	1	15
Total	88	94	135	9,593	136	9,489	16	195	22	330

NOTE.—Above Bangor, between Veasie and Enfield in 1901, 16 fishermen operated 8 gill nets, value $120, with 8 boats, value $120. The catch was 20 salmon, weighing 300 pounds, the value of which was $40.

Towns.	Boats, scows, and rafts.				Shore and accessory property.		Total investment.	
	1900.		1901.					
	No.	Value.	No.	Value.	1900.	1901.	1900.	1901.
Brooksville (Cape Rosier)	1	$25	1	$20	$15	$15	$310	$305
Bucksport	12	131	9	110	100	100	742	630
Castine	5	50	5	45	15	15	265	270
Hampden	2	24	2	24			69	84
Islesboro	2	55	5	95	15	25	350	480
Lincolnville	5	83	6	98	150	150	728	806
Ragged Island	2	80	2	80			880	880
Northport	6	90	6	90	85	75	1,045	865
Orland	15	196	17	204	30	40	770	820
Orrington	5	100	6	115	60	60	334	454
Penobscot	27	352	29	352	200	210	1,812	1,684
Searsport	4	55	4	55	70	60	665	655
South Brewer	1	12	1	12			27	27
Stockton and Prospect	28	294	33	347	120	120	1,508	1,561
Verona	27	530	28	535	685	690	3,715	3,835
Winterport	2	12	3	24	15	15	202	229
Bangor	1	12	1	12			27	27
Total	145	2,101	158	2,218	1,560	1,575	13,449	13,612

Extent of the salmon fishery of Penobscot River and Bay in 1900 and 1901—Continued.

Towns.	Catch of salmon.					
	1900.			1901.		
	No.	Lbs.	Value.	No.	Lbs.	Value.
Brooksville (Cape Rosier)	52	676	$280	132	1,700	$230
Bucksport	163	2,119	318	152	1,980	266
Castine	71	923	145	216	2,800	378
Hampden	21	250	52	31	403	87
Islesboro	208	2,704	447	442	5,746	773
Lincolnville	243	3,159	522	498	6,400	923
Ragged Island	151	1,510	151	83	541	54
Northport	342	4,450	735	477	6,200	834
Orland	67	881	170	163	2,118	405
Orrington	106	1,300	253	161	2,090	310
Penobscot	603	7,839	1,500	1,176	15,288	2,058
Searsport	201	2,600	470	459	4,475	651
South Brewer	9	75	16	17	230	42
Stockton and Prospect	466	6,058	1,100	1,079	13,487	1,889
Verona	777	9,324	1,554	1,618	21,034	3,131
Winterport	60	780	117	77	1,000	142
Bangor	1	12	2	20	260	50
Total	3,541	44,660	7,832	6,801	85,755	12,223

FISH TAKEN WITH SALMON.

With the salmon there are incidentally taken in the trap nets and weirs other marine or anadromous species, of which the following is nearly a complete list: Alewife (*Pomolobus pseudoharengus*), blueback (*Pomolobus æstivalis*), herring (*Clupea harengus*), shad (*Alosa sapidissima*), menhaden (*Brevoortia tyrannus*), striped bass (*Roccus lineatus*), cunner (*Tautogolabrus adspersus*), tautog (*Tautoga onitis*), sculpin (*Myoxocephalus grœnlandicus*), mackerel (*Scomber scombrus*), lump-fish (*Cyclopterus lumpus*), cod (*Gadus callarias*), tomcod (*Microgadus tomcod*), pollock (*Pollachius virens*), English hake (*Merluccius bilinearis*), sturgeon (*Acipenser sturio*), eel (*Anguilla chrisypa*), lamprey (*Petromyzon marinus*), smelt (*Osmerus mordax*), killi-fish (*Fundulus heteroclitus*), winter flounder (*Pseudopleuronectes americanus*), eel-back flounder (*Liopsetta putnami*), and dog-fish (*Squalus acanthias*).

The list includes a number of species prominent as food fishes, and others which are used extensively for bait and fertilizer, while a few are of little or no economic importance. The alewife, however, is the only one for which a distinct fishery is maintained in these waters. This species is caught in considerable quantities in the weirs and trap-nets with the salmon, but more extensively in weirs set especially for its capture. The pollock and dogfish are also worthy of notice as they are probably more or less inimical to the salmon.

Alewives.—So far as known the alewife (*Pomolobus pseudoharengus*) of the Penobscot breeds almost exclusively in Alamoosook Lake, though a few ascend the main Penobscot to the vicinity of Bradley, where they gain access to two ponds in very limited numbers.

The principal fishery for alewives on the Penobscot River is at Orland, in Eastern River, which is the avenue by which they reach

Alamoosook Lake. In this district a few of the weirs catch alewives exclusively, a larger number catch alewives principally, with a few salmon, and in the remainder, while salmon are taken chiefly, alewives form an important part of the catch. In other towns the extent of the alewife fishery seems to decrease with the distance from Orland. In Verona, Bucksport, and Penobscot the fishery is still quite important, but much less so in Castine, Stockton Springs, and more distant localities. It is estimated that in this fishery in 1901, in all localities, the number of weirs fished was 112, and the catch 592,587 alewives, and that in 1902 the number of weirs was 132, and the catch 406,265 alewives. The catch is disposed of in various ways. A few are marketed in a fresh condition at about 50 cents a hundred fish, some are pickled and sold in barrels, but the greater part of the catch is smoked and disposed of in the local markets at an average of about 80 cents a hundred fish. The fishermen sometimes receive as high as from 1 to 1¼ cents per fish. Alewives are rarely, if ever, sold by the pound in this region.

The "blueback" (*Pomolobus æstivalis*) is taken in nearly all the weirs with the alewives, but makes its appearance later in the season. It has been reported as sometimes taken at Orland Falls, above the lower dam. Though of excellent quality when fresh, its extreme fatness renders it difficult to cure in good condition, and it is therefore used chiefly for fertilizer, without any record being made of the number caught. While in some districts it is taken in greater numbers than the alewife, the catch in the aggregate is probably not so large as of that species.

Shad.—Shad are taken in very small numbers with the salmon. The fishermen, when referring to their catch, distinguish between the large "river shad" and the smaller "sea shad." Following is approximately the relative quantity of shad and salmon obtained in the weirs in a few localities: In Penobscot 10 fishermen caught 473 salmon and 106 shad; in Verona 9 fishermen caught 389 salmon and 56 shad; in Bucksport 5 fishermen caught 75 salmon and 37 shad, and in Winterport 2 fishermen caught 33 salmon and 70 shad; a total of 970 salmon and 269 shad. It should be explained that in some of these estimates only the "river shad" are included, the "sea shad" being omitted. The relative number of shad may therefore be nearly twice as large as the figures indicate.

Striped bass.—Striped bass are obtained in the Eastern River, where, in 1902, in the town of Orland, 86 were caught by 7 fishermen, and in Verona 47 were caught by 3 fishermen.

Pollock.—This species appeared in the river and bay in unusual numbers in 1901, and a considerable quantity of them was in some instances taken in the weirs. A fisherman in Penobscot reported the capture in his weirs of 132 pollock. In 1902, in Searsport, 300 pollock

were taken in 3 weirs; in Stockton Springs 85 pollock were caught in 4 weirs, while from 2 other weirs in the same locality 1,200 pounds, dressed weight, were taken. In Brooksville, in each of the years 1900 and 1901, about 200 pollock, weighing from 12 to 15 pounds each, were caught in 2 salmon traps. The presence of these active and ravenous fish is to be noted as having a possible influence in decreasing the supply of both salmon and alewives. It is not supposed that they will attack adult salmon, but the young salmon on their way to the marine feeding grounds must run the gauntlet of these foes, in consequence of which it is not improbable that their numbers are greatly reduced.

Dog-fish.—Dog-fish appeared on the coast in and near Penobscot Bay in unwonted numbers in 1902, and committed great havoc among the deep-water fishes. They appeared earlier than usual, being found near Monhegan Island as early as the middle of May, and becoming quite plentiful all along the coast in June; but August appears to have been as usual the month of greatest abundance. As illustrating their abundance and the damage wrought by them to the shore fisheries, Mr. John N. Harriman, of Stockton Springs, who fishes a great deal in the lower Penobscot Bay, near Matinicus, at Isle au Haut, etc., stated that he never knew dog-fish to be so plentiful. They came into the bay early, about June 1, and remained until late in the season. A Searsport fisherman also caught dog-fish just outside of Brigadier Island. Mr. Alvah G. Dorr, of Bucksport, who fishes for haddock, cod, etc., near Gotts Island, found dog-fish troublesome about the last of June. Around Mount Desert Rock, the large fleet of fishermen usually at work there were all driven from the fishing grounds by the dog-fish early in July, and had hardly begun again September 9. The dog-fish not only seize the bait on trawls, but attack other fish that have been hooked. On August 9 Mr. Dorr set his usual trawl, one "tub" of 500 hooks, about 1 mile outside of Gotts Island, and secured at one haul 217 dog-fish, 5 haddock, and a good many heads of haddock of which the rest had been eaten off by dog-fish. On the same day another man fishing in that locality, with about the same number of hooks, caught at one haul 224 dog-fish, 2 hake heads, and 3 skates. Mr. Dorr opened perhaps half a dozen dog-fish and found that nearly all were females with living young within, about 8 young fish to each mother, which would swim off on being thrown into the water. In the Penobscot River, near Sandy Point, a trawl set by Mr. Ernest A. Partridge, of Stockton Springs, in 15 fathoms of water, took 50 dog-fish in one day. Occasionally, but not very often, dog-fish are caught in the salmon weirs. The fishermen report 9 dog-fish caught in weirs at Stockton Springs, 6 at Penobscot, and 9 at Verona.

FISHERIES OF COLORADO.

The fisheries of Colorado, recently investigated by Mr. E. A. Tulian, in 1900 gave employment to 565 persons, of whom 546 were fishermen and the remainder shoresmen. The investment was $128,568, which included 101 boats, $2,400; 615 hand lines, $3,610; 16 seines, $1,755; 47 gill nets, $415; shore and accessory property, $118,888, and cash capital, $1,500. The products aggregated 1,360,166 pounds of fish, valued at $185,493. The catch with seines was 823,585 pounds, valued at $13,146; with gill nets, 14,980 pounds, valued at $3,645, and with hand lines, 521,601 pounds, valued at $168,702. The more important species taken were black-spotted trout, 208,655 pounds, $70,925; brook trout, 189,901 pounds, $59,512; carp, 658,950 pounds, $7,430, and rainbow trout, 130,155 pounds, $41,547. Black bass, cat-fish, crappie, Loch Leven trout, suckers, and yellow perch were caught in smaller quantities.

An interesting fact in connection with the fisheries of Colorado is that the catch is comprised largely of introduced species. The yield of native species, black-spotted trout and suckers, was only 290,390 pounds, valued at $72,146, while that of introduced species, consisting of black bass, brook trout, carp, cat-fish, crappie, rainbow trout, Loch Leven trout, and yellow perch, amounted to 1,069,776 pounds, valued at $113,347.

The fisheries are prosecuted in a large number of streams, creeks, ponds, and reservoirs, some of which are public waters, while others are ponds constructed and owned by individual citizens.

The following tables show the number of persons employed, the number and value of boats, apparatus of capture, the value of shore and accessory property, the amount of cash capital, and the quantity and value of the products of the fisheries of Colorado in 1900:

Table showing, by counties, the number of persons employed in the fisheries of Colorado in 1900.

Counties.	Fishermen.	Shoresmen.	Total.
Arapahoe, Boulder, Delta, Jefferson, Larimer, and Weld	116	18	134
Clear Creek	31		31
Dolores	10		10
Eagle	12		12
Garfield	32		32
Gilpin	25		25
Grand	50		50
Gunnison	133		133
Hinsdale	25	1	26
Lake	3		3
La Plata	11		11
Mineral and Rio Grande	13		13
Montezuma	10		10
Montrose	18		18
Otero	2		2
Pitkin	5		5
Saguache	40		40
San Miguel	9		9
Summit	1		1
Total	546	19	565

Table showing, by counties, the apparatus and capital employed in the fisheries of Colorado in 1900.

Counties.	Boats.		Hand lines.		Seines.			Gill nets.			Shore and accessory property.	Cash capital.	Total investment.
	No.	Value.	No.	Value.	No.	Length (yards).	Value.	No.	Length (yards).	Value.			
Arapahoe, Boulder, Delta, Jefferson, Larimer, and Weld	33	$1,100	120	$775	8	3,150	$1,530	21	2,550	$135	$52,173	$1,500	$57,213
Clear Creek	3	75	32	275	....	....	......	....	....	......	5,500	......	5,850
Dolores	....	......	10	50	....	....	......	....	....	......	......	......	50
Eagle	9	100	22	107	....	....	......	....	....	......	4,900	......	5,107
Garfield	2	50	32	255	....	....	......	....	....	......	......	......	305
Gilpin	5	100	65	350	....	....	......	....	....	......	2,500	......	2,950
Grand	10	200	50	300	....	....	......	....	....	......	250	......	750
Gunnison	2	50	130	650	3	175	75	....	....	......	2,000	......	2,775
Hinsdale	22	415	25	200	....	....	......	22	1,100	240	22,350	......	23,205
Lake	1	10	4	10	1	35	20	....	....	......	1,800	......	1,840
La Plata	2	50	10	35	1	100	40	....	....	......	1,800	......	1,925
Mineral and Rio Grande	2	50	25	175	....	....	......	4	200	40	9,165	......	9,430
Montezuma	....	......	10	50	....	....	......	....	....	......	......	......	50
Montrose	....	......	20	90	....	....	......	....	....	......	1,150	......	1,240
Otero	3	30	2	3	3	170	90	....	....	......	5,000	......	5,123
Pitkin	....	......	6	20	....	....	......	....	....	......	300	......	320
Saguache	....	......	40	200	....	....	......	....	....	......	......	......	200
San Miguel	4	120	9	45	....	....	......	....	....	......	......	......	165
Summit	3	50	3	20	....	....	......	....	....	......	10,000	......	10,070
Total	101	2,400	615	3,610	16	3,630	1,755	47	3,850	415	118,888	1,500	128,568

Table showing, by counties and apparatus, the yield of the fisheries of Colorado in 1900.

Apparatus and species.	Arapahoe, Boulder, Delta, Jefferson, Larimer, and Weld.		Clear Creek.		Dolores.		Eagle.		Garfield.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Black bass[a]	11,250	$730	......	......	......	......	......	......	......	......
Carp[a]	658,950	7,430	......	......	......	......	......	......	......	......
Cat-fish[a]	21,800	915	......	......	......	......	......	......	......	......
Crappie[a]	22,000	660	......	......	......	......	......	......	......	......
Suckers	81,735	1,221	......	......	......	......	......	......	......	......
Yellow perch[a]	18,500	680	......	......	......	......	......	......	......	......
Total	814,235	11,636	......	......	......	......	......	......	......	......
Gill nets:										
Black-spotted trout	6,765	1,190	......	......	......	......	......	......	......	......
Hand lines:										
Black bass[a]	4,500	595	......	......	......	......	......	......	......	......
Black-spotted trout	32,585	10,390	4,100	$1,635	3,750	$1,125	7,690	$2,600	30,350	$15,175
Brook trout[a]	30,250	9,520	9,520	3,790	......	......	3,581	1,092	2,400	1,200
Cat-fish[a]	750	60	......	......	......	......	......	......	......	......
Loch Leven trout[a]	......	......	270	108	......	......	......	......	......	......
Rainbow trout[a]	17,075	6,145	1,640	650	......	......	3,315	1,122	3,650	1,825
Yellow perch[a]	4,000	340	......	......	......	......	......	......	......	......
Total	89,160	27,050	15,530	6,183	3,750	1,125	14,586	4,814	36,400	18,200
Total by species:										
Black bass[a]	15,750	1,325	......	......	......	......	......	......	......	......
Black-spotted trout	39,350	11,580	4,100	1,635	3,750	1,125	7,690	2,600	30,350	15,175
Brook trout[a]	30,250	9,520	9,520	3,790	......	......	3,581	1,092	2,400	1,200
Carp[a]	658,950	7,430	......	......	......	......	......	......	......	......
Cat-fish[a]	22,550	975	......	......	......	......	......	......	......	......
Crappie[a]	22,000	660	......	......	......	......	......	......	......	......
Loch Leven trout[a]	......	......	270	108	......	......	......	......	......	......
Rainbow trout[a]	17,075	6,145	1,640	650	......	......	3,315	1,122	3,650	1,825
Suckers	81,735	1,221	......	......	......	......	......	......	......	......
Yellow perch[a]	22,500	1,020	......	......	......	......	......	......	......	......
Grand total	910,160	39,776	15,530	6,183	3,750	1,125	14,586	4,814	36,400	18,200

[a] Introduced.

Table showing, by counties and apparatus, the yield of the fisheries, etc.—Continued.

Apparatus and species.	Gilpin.		Grand.		Gunnison.		Hinsdale.		Lake.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Brook trout[a]					2,650	$690			200	$70
Gill nets:										
Black-spotted trout							6,515	$1,955		
Hand lines:										
Black-spotted trout	7,150	$3,550	19,900	$5,970	3,750	1,125	22,750	6,825		
Brook trout[a]	2,950	1,275			89,400	26,820	3,200	960	550	205
Rainbow trout[a]	2,925	1,310			61,950	18,585	2,300	690		
Total	13,025	6,135	19,900	5,970	155,100	46,530	28,250	8,475	550	205
Total by species:										
Black-spotted trout	7,150	3,550	19,900	5,970	3,750	1,125	29,265	8,780		
Brook trout[a]	2,950	1,275			92,050	27,510	3,200	960	750	275
Rainbow trout[a]	2,925	1,310			61,950	18,585	2,300	690		
Grand total	13,025	6,135	19,900	5,970	157,750	47,220	34,765	10,430	750	275

Apparatus and species.	La Plata.		Mineral and Rio Grande.		Montezuma.		Montrose.		Otero.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Black bass[a]									2,250	$225
Brook trout[a]	500	$150								
Cat-fish[a]									3,750	375
Total	500	150							6,000	600
Gill nets:										
Black-spotted trout			1,700	$500						
Hand lines:										
Black bass[a]									1,700	170
Black-spotted trout	2,000	800	46,000	13,800	2,300	$690	4,950	$1,485		
Brook trout[a]	1,600	555	3,500	1,050			1,550	465		
Rainbow trout[a]	250	75	36,000	10,800			750	225		
Total	3,850	1,430	85,500	25,650	2,300	690	7,250	2,175	1,700	170
Total by species:										
Black bass[a]									3,950	395
Black-spotted trout	2,000	800	47,700	14,300	2,300	690	4,950	1,485		
Brook trout[a]	2,100	705	3,500	1,050			1,550	465		
Cat-fish[a]									3,750	375
Rainbow trout[a]	250	75	36,000	10,800			750	225		
Grand total	4,350	1,580	87,200	26,150	2,300	690	7,250	2,175	7,700	770

[a] Introduced.

Table showing, by counties and apparatus, the yield of the fisheries, etc.—Continued.

Apparatus and species.	Pitkin.		Saguache.		San Miguel.		Summit.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Black bass[a]									13,500	$955
Brook trout[a]									3,350	910
Carp[a]									658,950	7,430
Cat-fish[a]									25,550	1,290
Crappie[a]									22,000	660
Suckers									81,735	1,221
Yellow perch[a]									18,500	680
Total									823,585	13,146
Gill nets:										
Black-spotted trout									14,980	3,645
Hand lines:										
Black bass[a]									6,200	765
Black-spotted trout	900	$360			5,000	$1,500	500	$250	193,675	67,280
Brook trout[a]	1,350	540	36,100	$10,830			600	300	186,551	58,602
Cat-fish[a]									750	60
Loch Leven trout[a]									270	108
Rainbow trout[a]	300	120							130,155	41,547
Yellow perch[a]									4,000	340
Total	2,550	1,020	36,100	10,830	5,000	1,500	1,100	550	521,601	168,702
Total by species:										
Black bass[a]									19,700	1,720
Black-spotted trout	900	360			5,000	1,500	500	250	208,655	70,925
Brook trout[a]	1,350	540	36,100	10,830			600	300	189,901	59,512
Carp[a]									658,950	7,430
Cat-fish[a]									26,300	1,350
Crappie[a]									22,000	660
Loch Leven trout[a]									270	108
Rainbow trout[a]	300	120							130,155	41,547
Suckers									81,735	1,221
Yellow perch[a]									22,500	1,020
Grand total	2,550	1,020	36,100	10,830	5,000	1,500	1,100	550	1,360,166	185,493

[a] Introduced.

FISHERIES OF THE MIDDLE ATLANTIC STATES.

The fisheries of the Middle Atlantic States in 1901 furnished employment to 93,661 persons, of whom 18,623 were on fishing and transporting vessels, 52,300 on boats in the shore fisheries, and 22,738 were engaged as shoresmen in wholesale fish establishments, menhaden factories, oyster canneries, and other occupations on shore connected with the fisheries. The number of persons in the fisheries of the various states was as follows: New York, 11,564; New Jersey, 12,030; Pennsylvania, 2,484; Delaware, 1,998; Maryland, 36,260; and Virginia, 29,325.

The total amount of capital invested in the fisheries of this region was $25,080,371. The investment in New York was $9,444,271; in New Jersey, $2,729,571; in Pennsylvania, $2,110,162; in Delaware, $657,197; in Maryland, $6,506,066; and in Virginia, $3,633,104. The number of vessels employed was 3,721, valued at $3,657,103, with a net tonnage of 54,761 tons, and outfits valued at $1,088,706. The number of boats in the shore fisheries was 36,237, valued at $2,023,880. The apparatus of capture used on vessels and boats was valued at $1,713,454, the shore and accessory property at $9,561,356, and the cash capital amounted to $7,035,872.

The products of the fisheries of those states aggregated 819,046,576 pounds, valued at $17,485,500. The yield in New York was 228,092,285 pounds, valued at $3,894,270; in New Jersey, 117,930,964 pounds, valued at $4,755,522; in Pennsylvania, 6,029,538 pounds, valued at $251,491; in Delaware, 5,835,186 pounds, valued at $203,372; in Maryland, 82,975,245 pounds, valued at $3,767,461; and in Virginia, 378,183,358 pounds, valued at $4,613,384. Some of the more important species taken in these fisheries were: Oysters, 19,749,677 bushels, $10,287,556; clams, hard and soft, 1,118,777 bushels, $1,074,834; shad, 31,897,687 pounds, $1,253,622; alewives, 33,198,605 pounds, $243,340; blue-fish, 16,317,795 pounds, $758,122; menhaden, 493,936,462 pounds, $987,228; squeteague, 23,496,383 pounds, $558,653; crabs, hard and soft, 70,951,965 in number, $495,385. Many other species were also obtained in large quantities.

Considering this region as a whole, the returns for 1901, as compared with those for 1897, indicate a large increase during the past few years in the extent of the fisheries. There has been some falling off since 1897 in the number of persons employed, but the investment has increased $4,973,900, and the products 224,874,366 pounds in quantity and $3,161,037 in value. There has also been an increase in the quantity and value of a number of important forms of fishing apparatus, such as seines, pound nets, trap nets, weirs, fyke nets, lines, eel and lobster pots, dredges, tongs, and crab scrapes.

Fisheries of the Middle Atlantic States, 1901.

Items.	New York.		New Jersey.		Pennsylvania.		Delaware.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Persons employed	11,564		12,030		2,484		1,998	
Vessels and outfits	633	$1,595,391	611	$810,288	27	$82,990	27	$22,447
Tonnage	11,641		6,714		519		237	
Boats	4,656	317,447	6,473	502,666	526	30,583	910	29,901
Seines	335	53,075	483	38,785	120	12,615	192	9,091
Gill nets	3,918	67,347	5,052	145,306	228	13,193	691	22,343
Pound nets, traps, and weirs	248	67,645	158	155,679			7	760
Stop nets			14	1,660	16	905		
Fyke nets	7,212	34,860	3,052	16,955	1,384	2,239	548	899
Bag nets			89	3,110				
Lines, hand and trawl		6,694		4,473		659		56
Fish baskets					122	1,686		
Crab dredges and scrapes			323	1,135				
Dredges, tongs, rakes, and hoes	6,972	39,159	10,699	101,593	80	2,650	243	2,430
Pots, eel	7,526	7,301	5,665	4,052	117	122	1,260	406
Pots, lobster	4,986	8,350	850	2,358			60	60
Minor apparatus		276		533		570		118
Shore and accessory property		4,221,226		785,428		1,168,243		352,086
Cash capital		3,025,500		155,550		793,707		216,600
Total		9,444,271		2,729,571		2,110,162		657,197

Fisheries of the Middle Atlantic States, 1901—Continued.

Products.	New York.		New Jersey.		Pennsylvania.		Delaware.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore			15,143	$259				
Alewives, fresh	1,363,614	$19,106	3,347,491	19,425	801,925	$2,448	597,374	$4,816
Alewives, salted			374,000	2,865	334,000	6,960		
Black bass			3,000	159	7,556	762		
Blue-fish	9,350,502	473,366	6,110,318	254,682	1,345	67	400	20
Bonito	194,727	7,307	1,459,418	34,841				
Butter-fish	590,682	25,809	3,008,301	84,119				
Cat-fish	174,144	8,822	256,859	14,229	193,199	10,163	130,280	5,075
Cero	1,570	123	22,789	714				
Cod	1,172,291	51,921	2,300,771	67,603			1,250	50
Crevalle			53	1				
Croaker			226,360	5,663	6,231	141	28,730	665
Drum			58,330	868			3,200	56
Eels, fresh	722,859	50,033	1,362,988	70,636	140,504	6,151	230,650	9,127
Flounders	1,274,308	49,949	1,668,221	52,993	22,411	709	5,500	226
German carp	281,494	17,142	227,419	14,290	161,895	9,795	198,040	9,752
Haddock	160,703	6,516	226,963	8,101				
Hake	36,580	860	26,841	749				
Herring, salted	180,000	2,025						
Horse mackerel			224	5				
King-fish	29,826	3,418	21,036	3,083				
Ling	26,140	516	317,868	4,375				
Mackerel	507,838	19,454	10,005	1,577				
Menhaden	180,409,767	454,505	32,910,666	88,041				
Mullet, fresh			36,300	1,842			5,350	180
Mullet, salted			57,814	5,123				
Mummichog	140,000	800						
Perch, white	51,987	3,390	1,270,097	81,699	3,465	206	242,360	11,357
Perch, yellow	25,893	2,014	16,569	1,038	1,225	62		
Pike and pickerel	2,050	185	2,560	210			16,310	654
Pollock	42,581	1,240						
Salmon, Atlantic	163	78	233	73	1,397	202		
Scup	804,589	25,379	607,099	16,367	22,593	585		
Sea bass	231,517	15,216	1,495,247	76,003	687,412	32,791	500	25
Sea-robins	385,000	433						
Shad, fresh	3,432,472	110,682	14,031,002	475,202	2,982,868	124,328	1,367,952	56,605
Shark			500	10				
Sheepshead	100	12	7,285	905				
Skates	139,200	140	2,375	48				
Spanish mackerel	4,104	933	38,928	5,729				
Spot	4,800	206	299,092	3,471				
Squeteague	2,346,683	73,939	11,973,394	315,770	3,600	115	722,435	13,915
Striped bass	71,840	9,102	354,467	49,734	13,092	1,153	47,595	5,114
Sturgeon	112,626	6,108	168,919	8,393	530	43	75,892	3,678
Caviar	4,291	2,215	19,108	10,959			10,307	6,766
Suckers	218,874	11,023	110,415	5,459	29,355	1,313	2,500	101
Sun-fish	12,875	1,099			3,970	317	200	2
Swell-fish	134,870	101						
Tautog	49,662	1,798	91,105	3,136			3,600	180
Tomcod	38,300	1,152	265,041	4,519				
Wall-eyed pike					14,675	2,321		
Whitebait	24,510	1,784						
Whiting	33,975	480	405,801	7,874				
Clams, hard	1,478,368	257,686	4,246,070	552,953			8,200	1,203
Clams, soft	779,450	58,843	902,770	54,918				
Clams, surf			13,336	500				
Crabs, hard	791,725	4,993	719,995	23,558				
Crabs, soft	40,440	2,104	417,910	51,861			150,509	5,587
Frogs					800	240		
King crabs			409,800	1,711			720,400	2,380
Lobsters	183,539	21,742	65,943	8,340			2,760	294
Mussels	262,400	1,860	374,600	920				
Oysters, market	12,380,921	1,703,985	14,646,345	1,696,767	282,352	35,517	678,300	40,290
Oysters, seed	3,808,525	268,555	10,617,572	550,918	302,638	14,232	534,030	22,318
Shells	2,286,000	1,330	144,000	32				
Scallops	1,109,724	167,337	114,000	3,200				
Shrimp			4,095	1,988				
Squid	180,846	5,114	17,748	826				
Terrapin	340	340	8,232	3,135			512	491
Turtle			20,130	1,053	10,500	870	50,050	2,445
Total	228,092,285	3,894,270	117,930,964	4,755,522	6,029,538	251,491	5,835,186	203,372

Fisheries of the Middle Atlantic States, 1901—Continued.

Items.	Maryland.		Virginia.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Persons employed	36,260		29,325		93,661	
Vessels and outfits	1,337	$1,137,362	1,086	$1,097,331	3,721	$4,745,809
Tonnage	20,067		15,583		54,761	
Boats	11,498	553,526	12,174	589,757	36,237	2,023,880
Seines	318	30,033	311	78,530	1,759	222,129
Gill nets	3,653	34,660	10,437	50,035	23,979	332,884
Pound, nets, traps, and weirs	1,017	99,265	1,605	314,116	3,049	637,465
Trammel nets	18	1,570			18	1,570
Stop nets					30	2,565
Fyke nets	4,064	11,372	729	7,444	16,889	73,769
Bag nets					89	3,110
Lines, hand and trawl		4,722		3,579		20,183
Fish baskets					122	1,686
Crab dredges and scrapes	2,831	10,247	933	2,256	4,087	13,638
Dredges, tongs, rakes, and hoes	19,766	157,398	14,461	72,592	52,221	375,822
Pots, eel	4,389	2,248	579	585	19,536	14,714
Pots, lobster					5,896	10,768
Minor apparatus		1,399		255		3,151
Shore and accessory property		2,164,749		869,624		9,561,356
Cash capital		2,297,515		547,000		7,035,872
Total		6,506,066		3,633,101		25,080,371
PRODUCTS.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore					15,143	$259
Alewives, fresh	13,454,757	$87,021	13,633,444	$110,524	33,198,605	243,340
Alewives, salted	292,400	4,287	280,000	4,900	1,280,400	19,012
Black bass	23,383	2,124	199,439	16,735	233,378	19,780
Blue-fish	100,145	4,378	755,085	25,609	16,317,795	758,122
Bonito	250	10	14,160	537	1,668,555	42,695
Butter-fish	458,700	11,505	1,071,860	28,551	5,129,543	149,984
Cat-fish	488,777	15,547	820,325	23,560	2,063,584	77,396
Cero	500	10			24,859	847
Cod	600	12	100	4	3,475,012	119,590
Crevalle	400	2	468,791	13,533	469,244	13,536
Croaker	303,405	4,239	3,937,168	53,493	4,501,894	64,201
Drum	53,450	570	228,172	2,707	343,152	4,201
Eels, fresh	334,811	12,309	105,815	4,430	2,897,627	152,686
Eels, salted	2,200	60			2,200	60
Eels, smoked	1,100	128			1,100	128
Flounders	51,205	1,625	209,394	6,253	3,231,039	111,755
German carp	163,180	5,319	127,930	2,940	1,159,958	59,238
Gizzard shad	6,010	133	5,250	100	11,260	233
Haddock					387,666	14,617
Hake					63,421	1,609
Harvest-fish	12,800	110			12,800	110
Herring, salted					180,000	2,025
Hickory shad	8,315	209	448,600	11,427	456,915	11,636
Hog-fish			44,892	3,586	44,892	3,586
Horse mackerel					224	5
King-fish	7,215	955	91,122	3,436	149,199	10,892
Ling					344,008	4,891
Mackerel	1,800	180			519,643	21,211
Menhaden	7,122,230	11,573	273,493,799	433,109	493,936,462	987,228
Moon-fish			70,400	2,161	70,400	2,161
Mullet, fresh	35,295	900	190,700	5,420	267,645	8,342
Mullet, salted					57,814	5,123
Mummichog					140,000	800
Perch, white	452,815	25,005	731,925	32,582	2,752,649	154,239
Perch, yellow	292,720	9,617	158,939	4,472	495,346	17,203
Pike and pickerel	67,530	5,390	32,103	2,848	120,553	9,287
Pollock					42,581	1,240
Pompano	140	14	96,186	7,549	96,326	7,563
Roach	200	1			200	1
Salmon, Atlantic					1,793	353
Scup	32,650	1,019			1,466,931	43,350
Sea bass	50,800	2,540	2,200	93	2,467,676	126,668
Sea-robins					385,000	433
Shad, fresh	3,094,181	120,177	6,972,212	366,203	31,880,687	1,253,197
Shad, salted	17,000	425			17,000	425
Shark					500	10
Sheepshead	1,350	52	8,430	348	17,165	1,317
Skates					141,575	188

Fisheries of the Middle Atlantic States, 1901—Continued.

Products.	Maryland.		Virginia.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Spanish mackerel	2,922	$348	520,142	$44,017	566,096	$51,027
Spot	22,470	387	806,827	24,306	1,133,189	28,370
Squeteague	1,018,775	26,921	7,431,496	127,993	23,496,383	558,653
Striped bass	824,418	68,568	527,507	45,177	1,838,919	178,848
Sturgeon	107,620	3,503	183,023	12,161	648,610	33,886
Caviar	5,818	3,486	18,318	10,204	57,842	33,630
Suckers	14,750	281	48,165	927	424,059	19,104
Sun-fish	3,970	72	4,000	95	25,015	1,585
Swell-fish					134,870	101
Tarpon			75	1	75	1
Tautog					144,367	5,114
Tomcod					303,341	5,671
Wall-eyed pike					14,675	2,321
Whitebait					24,510	1,784
Whiting			600	12	440,379	8,366
Clams, hard	107,600	14,384	1,764,680	134,777	7,604,918	961,003
Clams, soft					1,682,220	113,761
Clams, surf					13,336	500
Crabs, hard	9,824,793	85,884	6,113,277	52,863	17,449,790	167,298
Crabs, soft	4,303,582	202,563	1,288,424	65,972	6,200,865	328,087
Frogs	130	50	15,377	1,283	16,307	1,573
King crabs					1,130,200	4,091
Lobsters					252,242	30,376
Mussels					637,000	2,780
Oysters, market	39,798,927	3,031,518	42,473,683	2,621,915	110,260,528	9,129,992
Oysters, seed			12,724,446	301,541	27,987,211	1,157,564
Shells					2,430,000	1,362
Prawn			2,850	142	2,850	142
Scallops					1,223,724	110,537
Shrimp	728	708			4,823	2,696
Squid					198,594	5,940
Terrapin	1,593	1,139	5,130	1,444	15,807	6,549
Turtle	4,835	203	56,897	1,444	142,412	6,015
Total	82,975,245	3,767,461	378,183,358	4,613,384	819,046,576	17,485,500

NOTE.—The statistics of the oyster fishery given above are for the season of 1900-1901 for all territory except Long Island, New York; Delaware; Worcester County, Md.; and Accomac and Northampton counties, Va., where the data relating to this fishery were obtained for the calendar year 1901.

Supplementary table showing certain of the above products in number and bushels.

Products.	New York.		New Jersey.		Pennsylvania.		Delaware.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clams, hard, bush	184,736	$257,686	530,759	$552,953			1,025	$1,203
Clams, soft ....do	77,945	58,843	90,277	54,918				
Clams, surf ....do			1,667	500				
Crabs, hard ...No	2,375,175	4,993	2,159,985	23,558				
Crabs, soft .....do	121,320	2,104	1,253,730	51,861			451,527	5,587
King crabs ....do			204,900	1,711			360,200	2,380
Mussels .....bush	10,240	1,860	11,860	920				
Oysters, market, bushels	1,768,703	1,703,985	2,092,335	1,696,767	40,336	$35,517	96,900	40,290
Oysters, seed, bush	544,075	268,555	1,516,796	550,918	43,234	14,232	76,290	22,318
Shells ....do	38,100	1,330	2,400	32				
Scallops ....do	184,954	107,337	7,333	3,200				

Products.	Maryland.		Virginia.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clams, hard, bush	13,450	$14,384	220,585	$134,777	950,555	$961,003
Clams, soft ....do					168,222	113,761
Clams, surf ....do					1,667	500
Crabs, hard ...No	29,474,379	85,884	18,339,831	52,863	52,349,370	167,298
Crabs, soft .....do	12,910,746	202,563	3,865,272	65,972	18,602,595	328,087
King crabs ....do					565,100	4,091
Mussels .....bush					22,100	2,780
Oysters, market, bushels	5,685,561	3,031,518	6,067,669	2,621,915	15,751,504	9,129,992
Oysters, seed, bush			1,817,778	301,541	3,998,173	1,157,564
Shells. ....do					40,500	1,362
Scallops ....do					192,287	110,537

RECORDS OF THE DREDGING AND OTHER COLLECTING AND HYDROGRAPHIC STATIONS OF THE FISHERIES STEAMER ALBATROSS IN 1903.

LIEUT. FRANKLIN SWIFT, U. S. N., *Commanding.*

Compiled by HARRY C. FASSETT.

The dredging, trawling, and other collecting operations of the *Albatross* in 1903 were covered by a cruise in connection with the investigations of a special commission appointed at the request of the President to study the condition and needs of the Alaska salmon fisheries.

Previous to this cruise the last dredging station of the *Albatross* was No. 4190, on August 27, 1902, the last of the series in connection with the Hawaiian Islands investigations, the records of which may be found in the Report of the U. S. Fish Commission for 1902, pp. 397–432.

In the following records all stations where apparatus was employed for the purpose of collecting natural-history specimens are given serial dredging numbers in chronological order, and each piece of apparatus used at each station is given a separate line.

The tables include all hydrographic as well as dredging stations; with two exceptions (Nos. H. 4730 and H. 4777), all the hydrographic stations have an actual relation to the dredging stations in that they show the depth of water at the end of each dredge-haul, and consequently the range in depth within the limits of the haul, as well as the changes in temperature and character of bottom. As they constitute a logical part of the record, they are embodied in the tables in their chronologic order.

Of the 112 dredging stations shown in the following tables, 111 were actual net-dragging stations. At 95 the 8-foot Tanner beam trawl was employed, and at 16 the 9-foot Tanner trawl was used. The average maximum depth was 108 fathoms; average minimum depth, 92 fathoms; average mean depth, 100 fathoms.

Average time actually dragging on bottom, 20 minutes; average distance dragged over the bottom, .48 of a nautical mile.

One station was occupied solely for hand-line fishing; at other dredging stations lines were employed incidentally.

At 7 stations where the beam-trawl was used, the surface tow-net was also employed. At each station but a single haul was made, the average time of towing being 26 minutes, and the average distance towed through the water being one-half nautical mile.

Record of dredging and other collecting and hydrographic

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Gulf of Georgia, off Nanaimo, Vancouver Island, B. C.	*Fms.*		
1903. June 19	D. 4191	1.40 p.m. 1.59 p.m.	Sharp Point, Nanaimo Hbr., S. 1° E., 1.2 miles.	54 54–89	fne. dk. s. m. rky. fne. dk. s. m. rky.	H. O. No. 1278.
19	D. 4192	2.39 p.m. 3.24 p.m. 3.25 p.m.	Sharp Point, Nanaimo Hbr., S. 1° W., 1.6 miles.	89 89–97	gn. m. fne. s. gn. m. fne. s.	do
19	H. 4721	4.03 p.m.	Sharp Point, Nanaimo Hbr., S. 2° E., 2.1 miles.	97	gn. m. fne. s.	do
			Gulf of Georgia, Halibut Bank.			
20	D. 4193	9.48 a.m. 9.59 a.m.	Cape Roger Curtis, Bowen Id., S. 89° E., 10.8 miles.	23 23–18	gn. m. fne. s. gn. m. fne. s.	H. O. No. 1455.
20	H. 4722	10.23 a.m.	Cape Roger Curtis, Bowen Id., S. 86° E., 10.6 miles.	18	gy. s	do
20	D. 4194	10.49 a.m. 11.09 a.m. 11.28 a.m.	Cape Roger Curtis, Bowen Id., N. 83° E., 10.8 miles.	111 111–170	sft. gn. m. sft. gn. m.	do
20	H. 4723	11.50 a.m.	Cape Roger Curtis, Bowen Id., N. 82° E., 12 miles.	170	gn. m. fne. s.	do
20	D. 4195	12.15 p.m. 12.25 p.m.	Cape Roger Curtis, Bowen Id., N. 89° E., 11 miles.	14 14–14	gy. m. fne. s. gy. m. fne. s.	do
20	D. 4196	1.06 p.m. 1.16 p.m.	Cape Roger Curtis, Bowen Id., N. 89° E., 11 miles.	28 28–44	fne. gy. s fne. gy. s	do
20	H. 4724	1.30 p.m.	Cape Roger Curtis, Bowen Id., N. 87° E., 11.3 miles.	44	fne. gy. s	do
20	D. 4197	1.44 p.m. 1.54 p.m. 2.04 p.m.	Cape Roger Curtis, Bowen Id., S. 87° E., 11 miles.	90 90–47–31	stk. gn. m. fne. s. stk. gn. m. fne. s.	do
20	H. 4725	2.42 p.m.	Cape Roger Curtis, Bowen Id., S. 89° E., 11.5 miles.	31	gy. s. bk. sp	do
20	D. 4198	3.23 p.m. 3.38 p.m.	Entrance Island light, S. 15° W., 6 miles.	157 157–230	sft. gn. m. sft. gn. m.	C. S. No. 6300.
20	H. 4726	4.05 p.m.	Entrance Island light, S. 8° W., 5 miles.	230	sft. gn. m.	do
			Queen Charlotte Sound, off Fort Rupert, Vancouver Island, B. C.			
25	D. 4199	8.51 a.m. 9.05 a.m.	Center of Round Id., S. 46° W., 6.2 miles.	107 107–68	sft. gn. m. vol. s. sft. gn. m. vol. s.	H. O. No. 1453.
25	H. 4727	9.30 a.m.	Center of Round Id., S. 50° W., 6.5 miles.	68	gn. m. s. sponge	do
25	D. 4200	10.34 a.m. 10.44 a.m.	Center of Round Id., S. 50° W., 4.3 miles.	111 111–108	sft. gn. m. s. sft. gn. m. s.	do
25	H. 4728	11.15 a.m.	Center of Round Id., S. 57° W., 5.2 miles.	108	sft. gn. m. s.	do
25	D. 4201	11.34 a.m. 11.47 a.m.	Center of Round Id., S. 62° W., 3.9 miles.	138 138–145	sft. gn. m. s. brk. sh. sft. gn. m. s. brk. sh.	do
25	H. 4729	12.06 p.m.	Center of Round Id., S. 59° W., 4.9 miles.	145	lt. gn. m. fne. s.	do
25	D. 4202	2.10 p.m. 2.15 p.m.	Center of Round Id., NW., 1.7 miles.	36 36–25	gy. s gy. s	H. O. No. 1431.
25	H. 4731	2.40 p.m.	Center of Round Id., N. 22° W., 1.5 miles.	25	gn. m. s. brk. sh.	do
25	D. 4203	2.53 p.m. 3.01 p.m.	Center of Round Id., N. 22° W., 1.5 miles.	25 25–30	vol. s. g. brk. sh. sponge. vol. s. g. brk. sh. sponge.	do

stations of United States Fisheries Steamer Albatross, in 1903.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
76	65		Tnr. sdg. mch.					
76	65		8′ Tanner	Bottom	36	N. 7° E.	0.4	
68	65	47.1	Tnr. sdg. mch.					
68	65	47.1	8′ Tanner	Bottom	33	N. 11° W.	.4	
68	65		Surface tow	Surface	35	N. 11° W.	.4	Hauled once.
68	65	47.5	Tnr. sdg. mch.					
63	63	50.3	Tnr. sdg. mch.					
63	63	50.3	8′ Tanner	Bottom	21	S. 1° E.	.7	6 hand lines over while dredging; caught nothing. Large haul. Net slightly torn.
63	63	51.0	Tnr. sdg. mch.					
63	63	48.3	Tnr. sdg. mch.					
63	63	48.3	8′ Tanner	Bottom	30	S. 69° W.	.6	
63	63		Surface tow	Surface	13	S. 69° W.	.2	Hauled once.
63	63	47.8	Tnr. sdg. mch.					
65	63		Hand lead					
65	63		10 hand lines	Bottom	50	None		Poor catch.
73	66	53.8	Tnr. sdg. mch.					
73	66	53.8	8′ Tanner	Bottom	10	S. 19° W.	.3	
73	66		Tnr. sdg. mch.					
73	66	46.8	Tnr. sdg. mch.					Sounded while dred'g: 47 fms.
73	66		Surface tow	Surface	31	S. 48° W.	.6	Hauled once.
73	66	46.8	8′ Tanner	Bottom	21	S. 48° W.	.4	Much mud; net slightly torn by its weight.
68	66	51.8	Tnr. sdg. mch.					
71	66	46.8	Tnr. sdg. mch.					
71	66	46.8	8′ Tanner	Bottom	20	S. 42° W.	.4	
69	66	47.8	Tnr. sdg. mch.					
55	54	45.9	Tnr. sdg. mch.					
55	54	45.9	8′ Tanner	Bottom	15	S. 85° E.	.3	Very heavy load; net slightly torn from weight. Dug out part from boat; let rest go.
55	54	46.8	Tnr. sdg. mch.					
54	55	45.8	Tnr. sdg. mch.					
54	55	45.8	8′ Tanner	Bottom	15	N. 80° E.	.4	
54	55	45.7	Tnr. sdg. mch.					
54	55	45.5	Tnr. sdg. mch.					
54	55	45.5	8′ Tanner	Bottom	15	N. 41° E.	.4	
54	55	45.3	Tnr. sdg. mch.					
54	55	48.2	Tnr. sdg. mch.					Sounded while dred'g: 26, 23 fms.
54	55	48.2	8′ Tanner	Bottom	21	S. 74° W.	.5	
54	55	49.8	Tnr. sdg. mch.					
54	55	49.1	Tnr. sdg. mch.					Sounded while dred'g: 26 fms.
54	55	49.1	8′ Tanner	Bottom	27	N. 37° W.	.6	Lost one trawl weight.

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Queen Charlotte Sound, off Fort Rupert, Vancouver Island, B. C.—Continued.	*Fms.*		
1903. June 25	H. 4732	3.30 p. m.	Center of Round Id., N. 17° W., 0.9 mile.	30	gn. m. s. brk. sh.	H. O. No. 1431.
25	D. 4204	3.44 p. m. 4.04 p. m.	Center of Round Id., N. 79° W., 1.6 miles.	69 69–51	gn. m. vol. s. g gn. m. vol. s. g	do
25	H. 4733	4.37 p. m.	Center of Round Id., N. 62° W., 1.3 miles.	51	gn. m. s	do
			Admiralty Inlet, vicinity of Port Townsend, Wash.			
29	D. 4205	1.11 p. m. 2.03 p. m.	Admiralty Head light, N. 38° W., 1.3 miles.	26 26–15	r. sh r. sh	C. S. No. 6450.
29	H. 4734	2.21 p. m.	Admiralty Head light, N. 66° W., 0.8 mile.	15	r. sh	do
29	D. 4206	2.45 p. m. 2.53 p. m.	Admiralty Head light, N. 69° W., 2 miles.	25 25–22	r. sh r. sh	do
29	H. 4735	3.12 p. m.	Admiralty Head light, N. 84° W., 1.8 miles.	22	r. crs. s. sh. (barnacles).	do
29	D. 4207	3.41 p. m. 3.48 p. m.	Admiralty Head light, N. 20° W., 1.7 miles.	50 50–66	r. s. brk. sh r. s. brk. sh	do
29	H. 4736	4.18 p. m.	Admiralty Head light, N. 25° W., 3.1 miles.	66	gy. s. bk. sp. g. r	do
29	D. 4208	4.27 p. m. 4.36 p. m.	Admiralty Head light, N. 22° W., 3.5 miles.	83 83–99	rky rky	do
29	H. 4737	4.45 p. m.	Admiralty Head light, N. 20° W., 2.5 miles.	99	rky	do
30	D. 4209	8.56 a. m. 8.58 a. m.	Admiralty Head light, N. 50° W., 0.6 mile.	25 25–24	rky. crs. s. sh rky. crs. s. sh	do
30	H. 4738	9.12 a. m.	Admiralty Head light, N. 66° W., 0.8 mile.	24	rky. crs. s. sh	do
30	D. 4210	9.20 a. m. 9.28 a. m.	Admiralty Head light, N. 73° W., 0.9 mile.	25 25–23	crs. gy. s. sh. r crs. gy. s. sh. r	do
30	D. 4211	9.46 a. m. 9.52 a. m.	Admiralty Head light, N. 83° W., 1.3 miles.	23 23–19	crs. gy. s. brk. sh crs. gy. s. brk. sh	do
30	D. 4212	10.06 a. m. 10.20 a. m.	Admiralty Head light, N. 88° W., 1.4 miles.	19 19–25	crs. gy. s. brk. sh crs. gy. s. brk. sh	do
30	D. 4213	10.52 a. m. 10.50 a. m.	Admiralty Head light, N. 82° W., 2 miles.	25 25–23	gy. s. brk. sh. r gy. s. brk. sh. r	do
30	H. 4739	11.08 a. m.	Admiralty Head light, N. 88° W., 1.6 miles.	23	gy. s. brk. sh. r	do
			Port Townsend (Bay), Wash.			
July 1	D. 4214	8.43 a. m. 8.53 a. m.	Kala Point, N. 41° W., 1.1 miles.	14 14–17	sft. gn. m. br. c sft. gn. m. br. c	C. S. No. 6405.
1	H. 4740	9.00 a. m.	Kala Point, N. 58° W., 0.6 mile.	17	sft. gn. m. br. c	do
1	D. 4215	9.09 a. m. 9.13 a. m.	Kala Point, N. 83° W., 0.5 mile.	17 17–17	gn. m. fne. s. stk gn. m. fne. s. stk	do
1	H. 4741	9.32 a. m.	Kala Point, S. 27° W., 0.9 mile.	17	gn. m. fne. s. stk	do
			Admiralty Inlet, vicinity of Port Townsend, Wash.			
1	D. 4216	10.37 a. m. 10.48 a. m.	Bush Point light, S. 28° E., 3.3 miles.	79 79–101	rky rky	C. S. No. 6450.
1	H. 4742	11.14 a. m.	Bush Point light, S. 19° E., 2.9 miles.	101	g. brk. sh	do
1	D. 4217	11.28 a. m. 11.36 a. m.	Bush Point light, S. 27° E., 2.9 miles.	77 77–90	g. brk. sh g. brk. sh	do
1	H. 4743	11.54 a. m.	Bush Point light, S. 20° E., 2.5 miles.	90	g. p	do

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
54	55	49.3	Tnr. sdg. mch...	....	....	....	......	
54	55	47.6	Tnr. sdg. mch...	....	....	....	......	
54	55	47.6	8′ Tanner.......	Bottom .	29	S. 47° W...	0.4	
60	53	48.8	Tnr. sdg. mch...	....	....	....	......	
63	57	50.8	Tnr. sdg. mch...	....	....	....	......	
63	57	50.8	8′ Tanner.......	Bottom .	16	N. 2° W ...	.4	Net slightly torn.
63	57	......	Hand lead......	(Sounded bet'n H. 4734 and D. 4206: 15, 16, 16, 15½, 15½, 17, 19, 23 fms.)				
59	57	50.8	Hand lead......	....	....	....	......	Sounded while dred'g: 20, 20, 19½ fms.
59	57	50.8	8′ Tanner.......	Bottom .	20	N. 4° W ...	.4	
59	57	52.8	Tnr. sdg. mch...	....	....	....	......	
59	57	51.8	Tnr. sdg. mch...	....	....	....	......	
59	57	51.8	8′ Tanner.......	Bottom .	26	S. 32° E ...	.9	No catch; net wrecked.
59	57	50.3	Tnr. sdg. mch...	....	....	....	......	
59	57	50.5	Tnr. sdg. mch...	....	....	....	......	
59	57	50.5	8′ Tanner.......	Bottom .	6	N. 30° W ..	.3	Moderate current; very small catch.
59	57	50.3	Tnr. sdg. mch...	....	....	....	......	
58	53	50.3	Hand lead......	....	....	....	......	Sounded while dred'g: 24, 24, 24 fms.
58	53	50.3	8′ Tanner.......	Bottom .	11	N. 84° E...	.2	
58	53	......	Hand lead......	....	....	....	......	
58	53	50.7	Tnr. sdg. mch...	....	....	....	......	Sounded while dred'g: 18, 16, 17 fms.
58	53	50.7	8′ Tanner.......	Bottom .	14	N. 77° E...	.3	
58	53	50.9	Tnr. sdg. mch...	....	....	....	......	Sounded while dred'g: 23, 17½, 17 fms.
58	53	50.9	8′ Tanner.......	Bottom .	11	N. 77° E...	.2	
58	53	51.0	Tnr. sdg. mch...	....	....	....	......	Sounded while dred'g: 19, 18, 18, 21 fms.
58	53	51.0	8′ Tanner.......	Bottom .	18	S. 62° E ...	.3	
60	54	51.3	Tnr. sdg. mch...	....	....	....	......	Sounded while dred'g: 22 fms.
60	53	51.3	8′ Tanner.......	Bottom .	14	N. 68° W ..	.3	
60	54	52.8	Tnr. sdg. mch...	....	....	....	......	
56	53	......	Hand lead......	....	....	....	......	Sounded while dred'g: 17, 17½, 17½, 17 fms.
56	53	50.8	9′ Tanner.......	Bottom .	11	N. 20° W ..	.4	Much mud in net.
58	54	50.8	Tnr. sdg. mch...	....	....	....	......	
58	54	50.1	Tnr. sdg. mch...	....	....	....	......	Sounded while dred'g: 16½, 16½, 16½, 16½, 16½, 16 fms.
58	54	50.1	9′ Tanner.......	Bottom .	15	N. 10° W ..	.6	
58	54	50.2	Tnr. sdg. mch...	....	....	....	......	
61	55	49.0	Tnr. sdg. mch...	....	....	....	......	
61	55	49.0	8′ Tanner.......	Bottom .	20	S. 76° E ...	.4	Small catch.
57	53	48.8	Tnr. sdg. mch...	....	....	....	......	
57	53	49.3	Tnr. sdg. mch...	....	....	....	......	
57	53	49.3	8′ Tanner.......	Bottom .	13	S. 78° E ...	.2	
57	53	49.4	Tnr. sdg. mch...	....	....	....	......	

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Admiralty Inlet, vicinity of Port Townsend, Wash.—Continued.			
1903.				*Fms.*		
July 1	D. 4218	1.56 p. m. 1.59 p. m.	Olele Point, Oak Bay, S. 26° E., 1.9 miles.	16 16–16	sft. gn. m sft. gn. m	C. S. No. 6450.
1	D. 4219	2.13 p. m. 2.20 p. m.	Olele Point, Oak Bay, S. 27° E., 1.5 miles.	16 16–26–16	gn. m. s. brk. sh gn. m. s. brk. sh	do
1	D. 4220	2.50 p. m. 2.55 p. m.	Olele Point, Oak Bay, S. 20° E., 0.8 mile.	16 16–31	gn. m. s. brk. sh gn. m. s. brk. sh	do
1	D. 4221	3.24 p. m. 3.29 p. m.	Olele Point, Oak Bay, S. 37° W., 0.5 mile.	31 31–39	gn. m. s. brk. sh gn. m. s. brk. sh	do
1	D. 4222	3.51 p. m. 4.02 p. m.	Olele Point, Oak Bay, S. 61° W., 1.4 miles.	39 39–39	gy. s. brk. sh gy. s. brk. sh	do
1	H. 4744	4.24 p. m.	Olele Point, Oak Bay, S. 86° W., 1.5 miles.	39	gy. s. brk. sh	do
			Boca de Quadra, S. E. Alaska.			
6	D. 4223	8.30 a. m. 8.36 a. m.	Center of Grouse Islet, Mink Bay, N. 20° W., 2.5 miles.	48 48–57	sft. gn. m sft. gn. m	C. S. No. 8100
6	H. 4745	8.59 a. m.	Center of Grouse Islet, Mink Bay, N. 20° W., 2 miles.	57	dk. gn. m	do
6	D. 4224	9.57 a. m. 10.11 a. m.	Center of Cygnet Islet, S. 14° W., 4.2 miles.	156 156–166	dk. gn. m dk. gn. m	do
6	H. 4746	10.37 a. m.	Center of Cygnet Islet, S. 12° W., 3.2 miles.	166	dk. gn. m	do
6	D. 4225	11.21 a. m. 11.36 a. m.	Center of Cygnet Islet, S. 7° W., 2¼ miles.	181 181–149	dk. gn. m dk. gn. m	do
6	H. 4747	11.56 a. m.	Center of Cygnet Islet, S. 7° W., 1¾ miles.	149	dk. gn. m	do
			Vicinity of Naha Bay, Behm Canal, S. E. Alaska.			
7	D. 4226	9.06 a. m. 9.18 a. m.	Center of Cache Islet, S. 67° W., 1.3 miles.	31 31–62	rky rky	C. S. No. 8100
7	D. 4227	9.37 a. m. 9.43 a. m. 9.50 a. m.	Center of Cache Islet, S. 56° W., 0.9 miles.	62 62–65	dk. gn. m. fne. s dk. gn. m. fne. s dk. gn. m. fne. s	do
7	D. 4228	10.40 a. m. 10.45 a. m. 10.48 a. m.	Indian Point, N. 18° E., 0.9 mile.	41 41–134	g. sponge g. sponge g. sponge	do
7	H. 4748	11.36 a. m.	Indian Point, N. 30° E., 0.6 mile.	134	rky	do
7	D. 4229	1.04 p. m. 1.12 p. m. 1.24 p. m.	Indian Point, N. 69° E., 2.7 miles.	198 198–256	sft. gy. m sft. gy. m sft. gy. m	do
7	H. 4749	1.47 p. m.	Indian Point, N. 70° E., 4.5 miles.	256	stk. gn. m	do
7	D. 4230	2.11 p. m. 2.15 p. m. 2.28 p. m.	Indian Point, N. 70° E., 5 miles.	240 240–108	rky rky rky	do
7	H. 4750	2.41 p. m.	Indian Point, N. 70° E., 5.8 miles.	108	rky	do
7	D. 4231	3.22 p. m. 3.35 p. m.	Center of Trunk Id., N. 11° E., 0.5 mile.	113 113–82	gn. m. slate frag gn. m. slate frag	do
7	D. 4232	3.47 p. m. 4.12 p. m.	Center of Trunk Id., N. 64° E., 1.1 miles.	82 82–93–77	gn. m. sponge, rky. gn. m. sponge. rky.	do
7	H. 4751	4.35 p. m.	Center of Trunk Id., N. 81° E., 1.5 miles.	77	gn. m. g	do

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus used.	Trial. Depth.	Trial. Duration.	Drift. Direction.	Drift. Distance.	Remarks.
					Mins.		*Miles.*	
59	54	51.8	Tnr. sdg. mch					Sounded while dred'g: 15½, 15, 15, 14 fms.
59	54	51.8	8′ Tanner	Bottom	11	S. 21° E	.3	
59	54	51.8	Tnr. sdg. mch					Sounded while dred'g: 15, 21, 24, 24, 26, 24, 20, 16, 18 fms.
59	54	51.8	8′ Tanner	Bottom	19	S. 36° E	.5	
59	54	50.8	Hand lead					Sounded while dred'g: 18 23, 30, 25, 20, 31 fms.
59	54	50.8	8′ Tanner	Bottom	12	S. 52° E	.3	
59	54	51.8	(Depth est'd from chart and dredging cable.)					
59	54	51.8	8′ Tanner	Bottom	18	N. 72° E	.7	
59	54	50.8	Tnr. sdg. mch					
59	54	50.8	8′ Tanner	Bottom	19	S. 23° E	.4	
65	56	51.0	Tnr. sdg. mch					
61	59	44.6	Tnr. sdg. mch					
61	59	44.6	8′ Tanner	Bottom	19	N. 20° W	.4	
67	60	45.0	Tnr. sdg. mch					
71	61	43.7	Tnr. sdg. mch					
71	61	43.7	8′ Tanner	Bottom	22	S. 20° W	.5	Heavy load of mud, mixed with dead leaves, twigs, etc., in net. Net filled completely, and torn from weight of load.
71	61	43.6	Tnr. sdg. mch					
71	62	43.6	Tnr. sdg. mch					
71	62	43.6	9′ Tanner	Bottom	11	S. 7° W	.2	Net torn badly; probably by submerged tree.
71	62	43.7	Tnr. sdg. mch					
63	61	41.8	Tnr. sdg. mch					Sounded while dredging: 45 fms.
63	61	41.8	8′ Tanner	Bottom	15	N. 81° W	.3	
63	61	43.8	Tnr. sdg. mch					Lost sounding lead. Sounded while dred'g: 65, 65 fms.
63	61	......	Surface tow	Surface	32	N. 77° W	.6	Hauled once.
63	61	43.8	8′ Tanner	Bottom	24	N. 77° W	.5	Net torn slightly.
70	63	47.8	Tnr. sdg. mch					Sounded while dred'g: 52 fms.
70	63	......	Surface tow	Surface	14	N. 2° W	.3	Hauled once.
70	63	47.8	8′ Tanner	Bottom	11	N. 2° W	.2	Net completely filled with sponges.
81	62	......	Tnr. sdg. mch					
76	63	42.6	Tnr. sdg. mch					
76	63	......	Surface tow	Surface	33	S. 73° W	1.0	Hauled once.
76	63	42.6	8′ Tanner	Bottom	20	S. 73° W	.7	
74	62	42.4	Tnr. sdg. mch					
74	62	42.4	Tnr. sdg. mch					
74	62	......	Surface tow	Surface	23	S. 70° W	.4	Hauled once.
74	62	42.4	8′ Tanner	Bottom	10	S. 70° W	.2	Heavy strains, but no damage done.
74	62	43.0	Tnr. sdg. mch					
74	62	43.0	Tnr. sdg. mch					
74	62	43.0	8′ Tanner	Bottom	13	S. 85° W	.3	
74	62	43.3	Tnr. sdg. mch					Sounded while dred'g: 93 fms.
74	62	43.3	8′ Tanner	Bottom	18	N. 53° W	.3	Bridle stops parted; net capsized.
74	62	43.7	Tnr. sdg. mch					

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Vicinity of Yes Bay, Behm Canal.			
1903.				*Fms.*		
July 8	D. 4233	8.52 a. m. 9.03 a. m.	Cannery Point, Yes Bay, N. 55° W., 1 mile.	39 39–45	sft. gy. m. r. sft. gy. m. r.	C. S. No. 8100
8	D. 4234	9.20 a. m. 9.37 a. m.	Cannery Point, Yes Bay, N. 54° W., 1.5 miles.	45 45–45	gy. m. rky. gy. m. rky.	do
8	H. 4752	9.59 a. m.	Syble Point, East, ¼ mile.	45	gy. m. rky.	do
8	D. 4235	10.24 a. m. 10.45 a. m.	East End, Square Id., Spacious Bay, S. 48° W., 1.9 miles.	130 130–193– 181	gy. m. bk. sp gy. m. bk. sp	do
8	H. 4753	11.20 a. m.	East End, Square Id., Spacious Bay, N. 87° E., 1.2 miles.	181	gn. m	do
8	D. 4236	1.25 p. m. 1.43 p. m.	East End, Square Id., Spacious Bay, S. 34° W., 1.2 miles.	147 147–205– 182	r. crs. s. r. crs. s.	do
8	H. 4754	2.09 p. m.	East End, Square Id., Spacious Bay, N. 85° W., 0.9 mile.	182	gn. m	do
8	D. 4237	2.34 p. m. 2.52 p. m.	East End, Square Id., Spacious Bay, N. 85° W., 1 mile.	194 194–198– 192	gn. m gn. m	do
8	H. 4755	3.21 p. m.	East End, Square Id., Spacious Bay, N. 53° W., 2 miles.	192	gn. m	do
8	D. 4238	3.51 p. m. 4.13 p. m.	Nose Point, S. 66° E., 1.6 miles.	229 229–231	m. rky m. rky	do
8	H. 4756	4.38 p. m.	Nose Point, N. 42° E., 1.7 miles.	231	gn. m	do
			Junction of Clarence Strait and Behm Canal.			
9	D. 4239	1.02 p. m. 1.24 p. m.	Center of Guard Id., S. 28° E., 2.1 miles.	206 206–248	crs. s. rky crs. s. rky	C. S. No. 8100
9	D. 4240	2.15 p. m. 2.33 p. m.	Center of Guard Id., S. 70° E., 3.1 miles.	248 248–256	co. (hrd.) co. (hrd.)	do
9	H. 4757	3.05 p. m.	Center of Guard Id., S. 81° E., 4.1 miles.	256	dk. gn. m	do
9	D. 4241	3.31 p. m. 3.49 p. m.	Center of Guard Id., S. 83° E., 4.5 miles.	245 245–238	gn. m gn. m	do
9	H. 4758	4.16 p. m.	Center of Guard Id., N. 87° E., 5.5 miles.	238	gn. m	do
			Kasaan Bay, Prince of Wales Island, S. E. Alaska.			
11	D. 4242	7.58 a. m. 8.01 a. m.	Sandy Point, S. 20° E., 1.5 miles.	9 9–24	fne. g. brk. sh. rky. fne. g. brk. sh. rky.	C. S. No. 8100
11	H. 4759	8.46 a. m.	Sandy Point, S. 19° W., 1.1 miles.	24	crs. gy. s. m	do
11	D. 4243	9.03 a. m. 9.06 a. m.	Sandy Point, N. 62° W., 1.2 miles.	42 42–47	gn. m gn. m	do
11	H. 4760	9.30 a. m.	Sandy Point, N. 59° W., 2.1 miles.	47	gn. m	do
11	D. 4244	9.38 a. m. 9.41 a. m.	Sandy Point, N. 59° W., 2.2 miles.	50 50–54	gn. m gn. m	do
11	H. 4761	10.04 a. m.	Sandy Point, N. 61° W., 3.8 miles.	54	gn. m	do
11	D. 4245	10.58 a. m. 11.04 a. m.	Center of Round Id., S. 10° W., 0.4 mile.	95 95–98	dk. gn. m. s. sh. r dk. gn. m. s. sh. r	do
11	H. 4762	11.37 a. m.	Center of Round Id., S. 72° W., 0.5 mile.	98	dk. gn. m. s	do
11	D. 4246	2.15 p. m. 2.26 p. m.	East End, Long Id., N. 55° W., 3 miles.	123 123–101	gy. gn. m. crs. s. sh. gy. gn. m. crs. s. sh.	do
11	H. 4763	2.55 p. m.	East End, Long Id., N. 52° W., 1.9 miles.	101	gn. m. fne. s. brk. sh.	do
11	D. 4247	3.26 p. m. 3.40 p. m.	East End, Long Id., N. 78° W., 1.1 miles.	95 95–114– 89	gn. m. fne. s. brk. sh. gn. m. fne. s. brk. sh.	do
11	H. 4764	4.13 p. m.	East End, Long Id., S. 51° W., 0.9 mile.	89	s. sh	do

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
61	61	44.7	Tnr. sdg. mch					
64	61	44.7	8′ Tanner	Bottom	15	S. 58° E	.3	
64	61	43.7	Tnr. sdg. mch					Sounded while dred'g: 46 fms.
64	61	43.7	8′ Tanner	Bottom	19	S. 36° E	.3	Net badly torn.
65	61	44.9	Tnr. sdg. mch					
64	61	42.8	Tnr. sdg. mch					Sounded while dred'g: 193 fms.
64	61	42.8	8′ Tanner	Bottom	28	S. 7° E	.5	Heavy load in net.
64	61	42.7	Tnr. sdg. mch					
65	61	42.8	Tnr. sdg. mch					Sounded while dred'g: 205 fms.
65	61	42.8	8′ Tanner	Bottom	21	S. 9° E	.4	
64	60	42.6	Tnr. sdg. mch					
64	60	42.6	Tnr. sdg. mch					Sounded while dred'g: 198 fms.
64	60	42.6	8′ Tanner	Bottom	22	S. 29° E	.4	
66	63	42.6	Tnr. sdg. mch					
66	63	42.5	Tnr. sdg. mch					
66	63	42.5	8′ Tanner	Bottom	20	S. 9° E	.7	
68	65	42.4	Tnr. sdg. mch					
61	61	48.8	Tnr. sdg. mch					
61	61	48.8	8′ Tanner	Bottom	20	S. 68° W	.7	Net slightly torn; lost one trawl weight.
66	62	48.8	Tnr. sdg. mch					
66	62	48.8	8′ Tanner	Bottom	23	S. 67° W	.5	Large load in net.
66	62	47.8	Tnr. sdg. mch					
66	62	49.3	Tnr. sdg. mch					
66	62	49.3	8′ Tanner	Bottom	20	S. 50° W	.5	
64	60	48.8	Tnr. sdg. mch					
48	58	58.9	Tnr. sdg. mch					Sounded while dred'g: 21, 22, 24 fms.
48	58	58.9	8′ Tanner	Bottom	42	S. 73° E	.8	Net badly torn.
48	58	49.1	Tnr. sdg. mch					
55	57	49.1	Tnr. sdg. mch					
55	57	49.1	8′ Tanner	Bottom	21	S. 53° E	.5	
55	57	49.1	Tnr. sdg. mch					
55	57	49.0	Tnr. sdg. mch					
55	57	49.0	8′ Tanner	Bottom	20	S. 67° E	.6	
55	57	48.9	Tnr. sdg. mch					
59	62	48.9	Tnr. sdg. mch					
59	62	48.9	8′ Tanner	Bottom	17	S. 56° E	.2	Net slightly torn; brought up large rock.
59	62	49.0	Tnr. sdg. mch					
66	62	......	Tnr. sdg. mch					
66	62	44.1	8′ Tanner	Bottom	25	N. 56° W	.6	Large load.
66	62	44.1	Tnr. sdg. mch					
65	62	44.3	Tnr. sdg. mch					Sounded while dred'g: 111, 114, 106 fms.
65	62	44.3	8′ Tanner	Bottom	18	N. 28° W	.4	
65	63	......	Tnr. sdg. mch					Sounding wire flew off reel and kinked; thermometer did not trip.

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Eastern Passage (vicinity Stikine River Delta).	*Fms.*		
1903. July 13	D. 4248	8.50 a. m. 8.59 a. m.	Center of Simonof Id., N. 69° W., 2.8 miles.	71 71–67	gy. m gy. m	C. S. No. 8200
13	H. 4765	9.23 a. m.	Center of Simonof Id., N. 61° W., 5.2 miles.	67	gy. m	do
13	D. 4249	9.33 a. m. 9.40 a. m.	Center of Simonof Id., N. 61° W., 5.3 miles.	79 79–70	gy. m gy. m	do
13	H. 4766	10.04 a. m.	Center of Simonof Id., N. 53° W., 6 miles.	70	gy. m	do
13	D. 4250	10.17 a. m. 10.23 a. m.	Center of Simonof Id., N. 52° W., 6.2 miles.	66 66–61	gy. m gy. m	do
13	H. 4767	10.47 a. m.	Center of Simonof Id., N. 49° W., 7 miles.	61	gy. m	do
			Stephens Passage.			
14	H. 4768	7.45 a. m.	Hugh Point, S. 57° W., 3.5 miles.	59	rky	C. S. No. 8200
14	D. 4251	7.58 a. m. 8.15 a. m.	Hugh Point, S. 71° W., 3.4 miles.	198 198–198	rky rky	do
14	H. 4769	8.49 a. m.	Hugh Point, S. 85° W., 3.7 miles.	198	gy. m	do
14	D. 4252	9.03 a. m. 9.20 a. m.	Hugh Point, N. 89° W., 3.9 miles.	198 198–201	gy. m gy. m	do
14	H. 4770	9.44 a. m.	Hugh Point, N. 81° W., 4.5 miles.	201	gy. m.	do
14	D. 4253	10.51 a. m. 11.04 a. m.	Thistle Ledge, N. 53° E., 1.7 miles.	188 188–131–136	r. brk. sh. r. brk. sh.	do
14	H. 4771	11.23 a. m.	Thistle Ledge, N. 40° E., 1.3 miles.	136	r. brk. sh.	do
			Chilkoot Inlet.			
16	D. 4254	10.14 a. m. 10.17 a. m.	Indian Rock, S. 63° E., 3.3 miles.	45 45–51	gn. m gn. m	C. S. No. 8303
16	H. 4772	10.39 a. m.	Indian Rock, S. 61° E., 2.5 miles.	51	gn. m	do
			Taiya Inlet, Lynn Canal.			
16	D. 4255	12.53 p. m. 1.08 p. m.	Indian Rock, S. 9° W., 8.1 miles.	247 247–259	rky rky	do
16	H. 4773	1.32 p. m.	Indian Rock, S. 9° W., 6.8 miles.	259	(No specimen.)	do
			Chilkoot Inlet.			
16	D. 4256	2.30 p. m. 2.35 p. m.	Indian Rock, N. 3° W., 2 miles.	73 73–72	gy. m gy. m	do
16	H. 4774	2.57 p. m.	Indian Rock, N. 29° W., 1.6 miles.	72	gy. m	do
			Vicinity of Funter Bay, Lynn Canal.			
23	D. 4257	1.56 p. m. 2.22 p. m.	Clear Point, N. 63° E., 1.7 miles.	350 350	rky rky	C. S. No. 8302
23	D. 4258	3.27 p. m. 3.48 p. m.	Clear Point, N. 16° E., 3.5 miles.	300 300–313	m m	do
23	H. 4775	4.32 p. m.	Clear Point, N. 20° E., 5.9 miles.	313	m	do
			Dundas Bay, Icy Strait.			
24	D. 4259	1.41 p. m. 1.55 p. m.	Point Wimbleton, S. 46° W., 0.1 mile.	78 78–21	gy. s. brk. sh. r gy. s. brk. sh. r	C. S. No. 8050
24	D. 4260	2.24 p. m. 2.27 p. m.	Point Wimbleton, S. 25° W., 0.2 mile.	21 21–8½	crs. s. r crs. s. r	do
24	D. 4261	2.57 p. m. 2.59 p. m.	Point Wimbleton, S. 24° W., 0.3 mile.	10 10–8½–10	gn. m. rky gn. m. rky	do
24	D. 4262	3.26 p. m. 3.27 p. m.	Point Wimbleton, S. 10° W., 0.4 mile.	9 9–9	crs. s. rky crs. s. rky	do
24	D. 4263	3.40 p. m. 3.42 p. m.	Point Wimbleton, S. 20° W., 0.4 mile.	9 9–6½–8	crs. s. rky crs. s. rky	do

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
56	55	42.8	Tnr. sdg. mch					Strong current.
56	55	42.8	8′ Tanner	Bottom	20	S. 44° E	1.0	
56	55	43.3	Tnr. sdg. mch					
56	55	43.6	Tnr. sdg. mch					
56	55	43.6	8′ Tanner	Bottom	20	S. 11° E	.7	
56	55	43.0	Tnr. sdg. mch					
56	55	42.8	Tnr. sdg. mch					
56	55	42.8	8′ Tanner	Bottom	20	S. 15° E	.5	
56	56	43.3	Tnr. sdg. mch					
54	51	40.5	Tnr. sdg. mch					
54	51	40.9	Tnr. sdg. mch					Net badly torn; lost one trawl weight.
54	51	40.9	8′ Tanner	Bottom	20	S. 39° E	.4	
54	51	40.9	Tnr. sdg. mch					
54	52	40.8	Tnr. sdg. mch					
54	52	40.8	8′ Tanner	Bottom	20	S. 39° E	.4	
54	52	39.9	Tnr. sdg. mch					Sound. while dredg.: 131 fms.
54	52	40.9	Tnr. sdg. mch					Big haul of enormous barnacles.
54	52	40.9	8′ Tanner	Bottom	16	East	.2	
55	51	40.5	Tnr. sdg. mch					
57	54	40.0	Tnr. sdg. mch					
57	54	40.0	8′ Tanner	Bottom	20	SE	.4	
57	51	40.0	Tnr. sdg. mch					
60	53	36.8	Tnr. sdg. mch					Rich haul.
60	53	36.8	8′ Tanner	Bottom	14	S. 2° W	.3	
60	53	36.8	Tnr. sdg. mch					
61	58	38.5	Tnr. sdg. mch					
61	58	38.5	8′ Tanner	Bottom	20	NE	.6	
62	59	38.3	Tnr. sdg. mch					
64	57			(Depth estd. from chart and dredging cable.)				Lost all gear from Tnr. sdg. mch.
64	57		8′ Tanner	Bottom	24	S. 18° W	0.6	
64	57		Tnr. sdg. mch					
64	57	41.2	8′ Tanner	Bottom	27	S. 25° W	.7	
63	55	41.2	Tnr. sdg. mch					
62	50	44.7	Tnr. sdg. mch					
62	50	44.7	8′ Tanner	Bottom	9	N. 16° W	.1	Interfered with by drift ice.
59	51	44.2	Tnr. sdg. mch					Sound. while dredg.: 16, 12, 10½, 10, 9½, 9½, 9½, 9, 8½ fms.
59	51	44.2	8′ Tanner	Bottom	15	N. 16° W	.1	Net badly torn; much ice about.
59	51		Hand lead					Sound. while dredg.: 8½, 8½, 8½, 8½, 8½, 9, 9½, 10 fms.
59	51		8′ Tanner	Bottom	20	S. 70° W	.1	Interfered with by drift ice.
59	51		Hand lead					Sound. while dredg.: 9½, 8, 9 fms.
59	51		8′ Tanner	Bottom	7	S. 60° E	.1	Interfered with by drift ice.
53	51		Hand lead					Sound. while dredg.: 9, 7, 6½, 6½, 6¾, 6½, 6¾, 6¾, 7½, 8.
53	51		8′ Tanner	Bottom	25	S. 76° W	.1	Net badly torn; much ice, interfering with work.

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
			Off Freshwater Bay, Chatham Strait.			
1903.				*Fms.*		
July 25	D. 4264	2.42 p. m. 3.03 p. m.	North Passage Point, N. 50° W., 3 miles.	293 293–282	gn. m gn. m	C. S. No. 8300
25	H. 4776	3.38 p. m.	North Passage Point, N. 72° W., 3 miles.	282	gn. m	do
			Off Sitka Sound.			
31	D. 4265	10.16 a. m. 11.02 a. m.	Cape Edgecumbe, N. 69° E., 11 miles.	590 590	gn. m. rky gn. m. rky	C. S. No. 8000
31	D. 4266	1.27 p. m. 2.00 p. m.	Cape Edgecumbe, N. 89° E., 9.2 miles.	349 349–250	gy. gn. m. rky gy. gn. m. rky	do
31	D. 4267	4.34 p. m. 5.31 p. m.	Cape Edgecumbe, S. 84° E., 21 miles.	922 922	sft. gy. m sft. gy. m	do
			Afognak Bay, Afognak Island.			
Aug. 3	D. 4268	1.56 p. m. 1.59 p. m.	Point Lipsett, N. 83° W., 1.9 miles.	16 16–17½	gy. s. brk. sh gy. s. brk. sh	F. C. Survey, Edn. 1900.
3	D. 4269	2.24 p. m. 2.29 p. m.	Point Lipsett, S. 82° W., 1.5 miles.	14½ 14½–19–14	hrd. gy. s. r hrd. gy. s. r	do
3	D. 4270	3.18 p. m. 3.20 p. m.	Point Lipsett, SW., 1 mile.	14 14–19–16	hrd. gy. s. r hrd. gy. s. r	do
3	D. 4271	3.49 p. m. 3.55 p. m.	Point Lipsett, S. 8° W., 1 mile.	11½ 11½–20–17	hrd. gy. s. r hrd. gy. s. r	do
3	D. 4272	4.13 p. m. 4.17 p. m.	Point Lipsett, S. 15° E., 1.7 miles.	17 17–12	stk. m stk. m	do
			Alitak Bay, Kadiak Id.			
6	D. 4273	8.44 a. m. 8.50 a. m.	Cape Alitak, S. 41° W., 7.1 miles.	36 36–41	gn. m. fne. s gn. m. fne. s	do
6	D. 4274	9.13 a. m. 9.22 a. m.	Cape Alitak, S. 44° W., 6.2 miles.	41 41–35	gn. m. fne. s gn. m. fne. s	do
6	D. 4275	9.47 a. m. 9.56 a. m.	Cape Alitak, SW., 5.5 miles.	35 35–36	gn. m. fne. s gn. m. fne. s	do
6	H. 4778	10.23 a. m.	Cape Alitak, SW., 4.7 miles.	36	gn. m. fne. s	do
6	D. 4276	10.55 a. m. 11.03 a. m.	Cape Alitak, N. 88° W., 4 miles.	22 22–25	fne. s. m fne. s. m	do
6	D. 4277	11.24 a. m. 11.32 a. m.	Cape Alitak, S. 81° W., 4.4 miles.	25 25–25	gy. s gy. s	do
6	D. 4278	1.06 p. m. 1.11 p. m.	Cape Alitak, S. 71° W., 4.8 miles.	27 27–29	dk. gy. m dk. gy. m	do
6	D. 4279	1.38 p. m. 1.41 p. m.	Cape Alitak, S. 71° W., 5.5 miles.	29 29–29	dk. gy. m. r dk. gy. m. r	do
6	H. 4779	2.03 p. m.	Cape Alitak, S. 59° W., 5.6 miles.	29	dk. gy. m. r	do
			Chignik Bay.			
10	D. 4280	8.27 a. m. 8.31 a. m.	Tuliumnit Pt., S. 77° E., 9.2 miles.	32 32–42	gn. m. bk. s gn. m. bk. s	F. C. Survey, Edn. 1897.
10	D. 4281	8.52 a. m. 9.00 a. m.	Tuliumnit Pt., S. 69° E., 9.2 miles.	42 42–43	gn. m gn. m	do
10	H. 4780	9.15 a. m.	Tuliumnit Pt., S. 67° E., 9 miles.	43	gn. m. fne. s	do

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
58	57	......	Tnr. sdg. mch...	....	....	....	....	
58	57	41.1	8′ Tanner.......	Bottom .	30	N. 30° E...	0.5	Scale on accumulator broke.
58	57	41.1	Tnr. sdg. mch...	....	....	....	....	
53	53	38.2	Sig. sdg. mch ...	....	....	....	....	
53	53	38.2	8′ Tanner.......	Bottom .	27	N. 49° E...	1.0	Lost trawl frame, but recovered net badly torn.
62	56	39.2	Sig. sdg. mch ...	....	....	....	....	Shoaled to 250 fms., as indicated by dredg. cable.
62	56	39.2	8′ Tanner.......	Bottom .	16	N. 42° E...	.7	Net wrecked; lost beam from frame, and runners were badly bent and twisted.
59	58	36.2	Sig. sdg. mch ...	....	....	....	....	
59	58	36.2	8′ Tanner.......	Bottom .	21	N. 88° W...	.7	
57	54	50.9	Tnr. sdg. mch...	....	....	....	....	Sound. while dredg.: 17¾ fms.
57	54	50.9	8′ Tanner.......	Bottom .	19	NW.........	.5	
57	54	......	Hand lead.......	....	....	....	....	Sound. while dredg.: 19, 17½, 13, 13, 14 fms.
57	54	......	8′ Tanner.......	Bottom .	22	N. 50° W...	.5	Frame of trawl bent and twisted.
56	53	......	Hand lead.......	....	....	....	....	Sound. while dredg.: 17, 17½, 19, 16 fms.
56	53	......	9′ Tanner.......	Bottom .	20	N. 47° W...	.5	
56	53	......	Hand lead.......	....	....	....	....	Sound. while dredg.: 19, 19, 20, 17½ fms.
56	53	......	9′ Tanner.......	Bottom .	20	N. 50° W...	.7	
52	54	......	Hand lead.......	....	....	....	....	Sound. while dredg.: 15, 14½, 13, 12½, 12 fms.
52	54	......	9′ Tanner.......	Bottom .	20	N. 20° W...	.5	
53	51	......	Tnr. sdg. mch...	....	....	....	....	Lost 36 fms. sdg. wire, 26 ft. lead, and N. & Z. thermometer.
53	51	......	9′ Tanner.......	Bottom .	20	S. 17° W...	.8	
53	51	......	Tnr. sdg. mch...	....	....	....	....	
53	51	......	9′ Tanner.......	Bottom .	20	S. 36° W...	.6	
53	51	......	Tnr. sdg. mch...	....	....	....	....	
53	51	44.4	9′ Tanner.......	Bottom .	24	S. 46° W...	.6	
52	51	44.4	Tnr. sdg. mch...	....	....	....	....	
55	52	......	Tnr. sdg. mch...	....	....	....	....	
55	52	......	9′ Tanner.......	Bottom .	20	N. 23° E...	.8	
55	52	......	Tnr. sdg. mch...	....	....	....	....	
55	52	......	9′ Tanner.......	Bottom .	18	N. 52° E...	.7	
64	53	......	Tnr. sdg. mch...	....	....	....	....	
64	53	......	9′ Tanner.......	Bottom .	18	N. 65° E...	.5	
63	53	......	Tnr. sdg. mch...	....	....	....	....	
63	53	......	9′ Tanner.......	Bottom .	20	N. 15° W...	.9	
63	53	......	Tnr. sdg. mch...	....	....	....	....	
53	51	......	Tnr. sdg. mch...	....	....	....	....	Sound. while dredg.: 42 fms.
53	51	......	9′ Tanner.......	Bottom .	20	N. 25° E...	.9	
54	51	47.0	Tnr. sdg. mch...	....	....	....	....	
54	51	47.0	9′ Tanner.......	Bottom .	11	N. 40° E...	.3	Heavy strains, but no damage done.
54	51	......	Tnr. sdg. mch...	....	....	....	....	

Record of dredging and other collecting and hydrographic stations of

Date.	Station numbers.	Time of day.	Positions by true bearings.	Depth.	Character of bottom.	Chart used.
1903.			*Chignik Bay*—Cont'd.	*Fms.*		
Aug. 10	D. 4282	9.24 a. m. 9.26 a. m.	Tuliumnit Pt., S. 66° E., 8.8 miles.	24 24–21	gy. s. br. sp. brk. sh. r. gy. s. br. sp. brk. sh. r.	F. C. Survey, Edn. 1897.
10	H. 4781	9.43 a. m.	Tuliumnit Pt., S. 64° E., 8.5 miles.	21	gy. s. br. sp. brk. sh. r.	.....do ....
10	D. 4283	9.57 a. m. 10.00 a. m.	Tuliumnit Pt., S. 61° E., 7.5 miles.	30 30–41–30	bk. s. br. sp........ bk. s. br. sp........	....do ....
10	D. 4284	10.22 a. m. 10.30 a. m.	Tuliumnit Pt., S. 61° E., 7.1 miles.	30 30–26	gn. m. s. r .... gn. m. s. r	....do ....
10	D. 4285	10.43 a. m. 10.46 a. m.	Tuliumnit Pt., S. 56° E., 6.2 miles.	31 31–40–59	gy. s. brk. sh ..... gy. s. brk. sh	....do ....
10	D. 4286	11.13 a. m. 11.23 a. m.	Tuliumnit Pt., S. 55° E., 5.9 miles.	57 57–63	gn. m. r .... gn. m. r	....do ....
10	H. 4782	11.40 a. m.	Tuliumnit Pt., S. 52° E., 5.3 miles.	63	gn. m	.....do ....
			Uyak Bay, Kadiak Id.			
14	D. 4287	2.01 p. m. 2.04 p. m.	South end of Harvester Island, N. 56° W., 4.7 miles.	66 66–67	gy. m .... gy. m	....do ....
14	D. 4288	2.26 p. m. 2.38 p. m.	South end of Harvester Island, N. 60° W., 4.3 miles.	67 67–69	gy. m .... gy. m	....do ....
14	H. 4783	3.00 p. m.	S. end Harvester Id., N. 65° W., 3.6 miles.	69	gy. m............	.....do ....
14	D. 4289	3.15 p. m. 3.20 p. m.	S. end Harvester Id., N. 80° W., 2.6 miles.	80 80–74	gy. m .... gy. m	....do ....
14	D. 4290	3.58 p. m. 4.01 p. m.	S. end Harvester Id., S. 38° W., 1.5 miles.	99 99–99	sft. gy. m. fne. bk. s. sf. gy. m. fne. bk. s.	....do ....
			Shelikof Strait.			
15	D. 4291	9.01 a. m. 9.04 a. m.	Cape Uyak, S. 51° W., 8.5 miles.	65 65–48	bu. m. s. g .... bu. m. s. g	C. S. No. 8500 .
15	H. 4784	9.25 a. m.	Cape Uyak, S. 54° W., 7.9 miles.	48	bu. m. s. g........	.....do ....
15	D. 4292	9.51 a. m. 9.56 a. m.	Cape Uyak, S. 41° W., 7.2 miles.	102 102–94	bu. m. fne. s....... bu. m. fne. s.......	....do ....
15	H. 4785	10.23 a. m.	Cape Uyak, S. 41° W., 6.2 miles.	94	bu. m. fne. s.......	.....do ....
15	D. 4293	10.46 a. m. 10.51 a. m.	Cape Uyak, S. 10° W., 5.8 miles.	112 112–106	bu. m. fne. s....... bu. m. fne. s.......	....do ....
15	D. 4294	11.19 a. m. 11.27 a. m.	Cape Uyak, S. 16° W., 4 miles.	106 106–103–97	bu. m. fne. s....... bu. m. fne. s.......	....do ....
15	H. 4786	11.44 a. m.	Cape Uyak, S. 12° W., 3 miles.	97	bu. m. fne. s.......	.....do ....
15	D. 4295	1.03 p. m. 1.08 p. m.	Cape Uyak, N. 82° E., 4.3 miles.	92 92–92	sft. gy. m .... sft. gy. m.........	....do ....
			Monti Bay, Yakutat Bay.			
18	D. 4296	9.50 a. m. 9.52 a. m.	Ankau Head, S. 74° W., 1.3 miles.	35 35–37	dk. bu. m. sh ...... dk. bu. m. sh	C. S. No. 8455 .
18	D. 4297	10.12 a. m. 10.22 a. m.	Ankau Head, S. 50° W., 0.8 mile.	37 37–35	bu. m .... bu. m	....do ....
18	D. 4298	10.43 a. m. 10.52 a. m.	Ankau Head, S. 22° W., 0.7 mile.	35 35–33–30	bu. m. gy. s........ bu. m. gy. s........	....do ....
18	H. 4787	11.52 a. m.	Ankau Head, S. 1° W., 1.1 miles.	30	gy. s.............	.....do ....
			Off Shakan, Sumner Strait, S. E. Alaska.			
24	D. 4299	9.58 a. m. 10.10 a. m.	Point Amelius, N. 75° W., 5 miles.	153 153–218	s. r............... s. r...............	C. S. No. 8050 .
24	D. 4300	10.34 a. m. 10.58 a. m.	Point Amelius, S. 77° W., 5.5 miles.	218 218–185	r. m .... r. m	....do ....
24	D. 4301	11.29 a. m. 11.35 a. m.	Point Amelius, S. 79° W., 4.5 miles.	171 171–171	gy. s. m. r .... gy. s. m. r	....do ....
24	D. 4302	1.03 p. m. 1.23 p. m.	Point Amelius, S. 80° W., 5.8 miles.	212 212–169	bu. m .... bu. m............	....do ....
24	H. 4788	1.52 p. m.	Point Amelius, S. 81° W., 6.2 miles.	169	gn. m. s	.....do ....

United States Fisheries Steamer Albatross, in 1903—Continued.

Temperatures.			Apparatus used.	Trial.		Drift.		Remarks.
Air.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
					Mins.		*Miles.*	
54	51		Tnr. sdg. mch					
54	51		9′ Tanner	Bottom	15	N. 65° E	0.2	Frame bent; net wrecked; lost one trawl weight.
54	51		Tnr. sdg. mch					
56	51		Tnr. sdg. mch					Sound. while dredg.: 31, 41 fms.
56	51		8′ Tanner	Bottom	20	S. 65° E	.3	
56	51		Tnr. sdg. mch					Sound. while dredg.: 26 fms.
56	51		8′ Tanner	Bottom	2	S. 50° E	.1	Gear fouled on bottom, but no damage.
56	51		Tnr. sdg. mch					Sound. while dredg.: 40, 59 fms.
56	51		8′ Tanner	Bottom	21	East	.3	
57	55	47.2	Tnr. sdg. mch					
57	55	47.2	8′ Tanner	Bottom	15	S. 76° E	.4	Much mud in net; net torn slightly.
57	55		Tnr. sdg. mch					
63	58		Tnr. sdg. mch					
63	58		8′ Tanner	Bottom	20	N. 27° W	.4	
63	58	43.0	Tnr. sdg. mch					Sound. while dredg.: 69 fms.
63	58	43.0	8′ Tanner	Bottom	20	N. 31° W	.4	
63	58	42.2	Tnr. sdg. mch					
63	58	42.2	Tnr. sdg. mch					Sound. while dredg.: 74 fms.
63	58	42.2	8′ Tanner	Bottom	15	N. 35° W	.2	
63	58		Tnr. sdg. mch					
63	58		8′ Tanner	Bottom	15	North	.3	
66	57		Tnr. sdg. mch					
66	57		8′ Tanner	Bottom	20	S. 19° W	.6	
66	57		Tnr. sdg. mch					
66	57	39.8	Tnr. sdg. mch					
66	57	39.8	8′ Tanner	Bottom	25	S. 35° W	.8	
66	57		Tnr. sdg. mch					
66	57		Tnr. sdg. mch					
66	57		8′ Tanner	Bottom	20	S. 1° W	1.0	
65	60		Tnr. sdg. mch					Sound. while dredg.: 103 fms.
65	60		8′ Tanner	Bottom	14	S. 25° W	.6	
65	60		Tnr. sdg. mch					
63	56		Tnr. sdg. mch					
63	56		8′ Tanner	Bottom	20	S. 11° E	1.2	Moderate current.
57	57		Tnr. sdg. mch					
57	57		8′ Tanner	Bottom	17	N. 80° W	.4	
59	56	46.0	Tnr. sdg. mch					Sound. while dredg.: 37 fms.
59	56	46.0	8′ Tanner	Bottom	18	N. 64° W	.3	
59	56		Tnr. sdg. mch					Sound. while dredg.: 33 fms.
59	56		8′ Tanner	Bottom	23	N. 31° W	.4	
59	56		Tnr. sdg. mch					
60	48		Tnr. sdg. mch					
60	48		8′ Tanner	Bottom	21	N. 12° E	1.1	
60	48		Tnr. sdg. mch					Sound. while dredg.: 185 fms.
60	48		8′ Tanner	Bottom	5	N. 15° E	.1	Gear fouled on bottom, but no damage done.
55	49		Tnr. sdg. mch					
55	49		8′ Tanner	Bottom	13	N. 27° E	.4	
54	50	44.2	Tnr. sdg. mch					
54	50	44.2	8′ Tanner	Bottom	21	S. 85° E	.5	Net slightly torn.
55	54		Tnr. sdg. mch					

Explanations.

The time of a sounding is the time when the plummet strikes the bottom by the ship's local time.

The time of a net or dredge haul is the hour when such apparatus is in place or position and the actual towing or dredging commenced.

Where two surface nets were used the actual time that both nets were in the water together is given as if but one piece of gear were employed.

The remarks show how many single hauls of a surface net were made at each station.

Almost invariably the dredging stations were located by soundings at each end of the line, and a majority of the dredgings were on lines of continuous development.

The drift is the direction and distance traveled over the ground in the case of bottom gear, and through the water—after getting in position—in the case of other nets. No account is taken of the distance traveled by the ship while nets are being lowered or hoisted.

List of abbreviations employed in these records.

Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.
alg	algæ.	gy	gray.	rky	rocky.
bk	black.	h or hr	hour.	rot	rotten.
botm	bottom.	hrd	hard.	s	sand.
br.	brown.	lav	lava.	sft	soft.
brk	broken.	lge	large.	sh	shells.
bu	blue.	lt	light.	slat	slate color.
c	clay.	m	mud.	sml	small.
choc	chocolate color.	mang	manganese.	sp	specks.
co	coral.	mi	miles.	st	stones.
corln	coralline.	min	mineral.	stbd	starboard.
crs	coarse.	mts	minutes.	stf	stiff.
dd	dead.	nod	nodules.	stk	sticky.
dk	dark.	oz	ooze.	vol	volcanic.
estd	estimated.	p	pebbles.	wh	white.
fms	fathoms.	part	particles.	yl	yellow.
fne	fine.	posn	position.	Sig. sdg. mch	Sigsbee sounding machine.
for	foraminifera.	pter	pteropods.	Surface tow	Surface tow net.
frag	fragments.	pum	pumice.	8′ Tanner	8-foot Tanner beam trawl.
g	gravel.	r	rock.	9′ Tanner, etc.	9-foot Tanner beam trawl, etc.
glob	globigerina.	rad	radiolaria.	Tnr. sdg. mch.	Tanner sounding machine.
gn	green.	rd	red.		

REPORT OF THE SPECIAL COMMISSION FOR THE INVESTIGATION OF THE LOBSTER AND THE SOFT-SHELL CLAM.

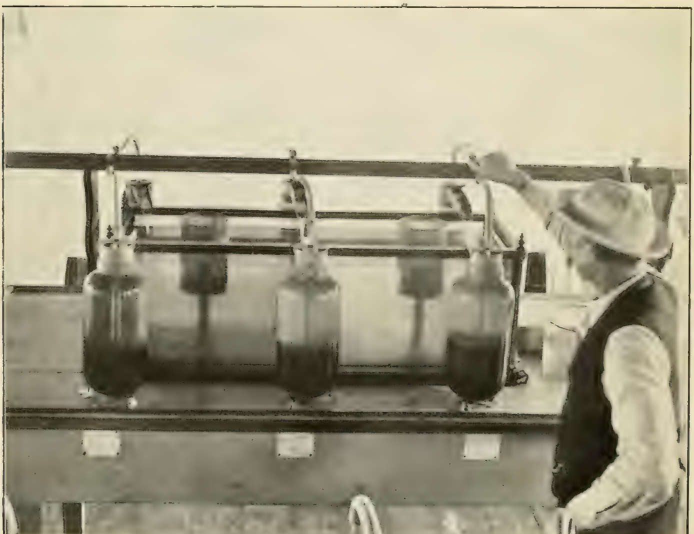
I. General Account of the Lobster and Clam Investigations. By Hugh M. Smith.

II. Experiments in Lobster Rearing. By George H. Sherwood.

III. The Causes of Death in Artificially Reared Lobster Fry. By Frederic P. Gorham.

IV. Conditions Governing Existence and Growth of the Soft Clam. By James L. Kellogg.

METHOD OF STRIPPING EGGS FROM A LOBSTER



IMPROVED ARRANGEMENT FOR HATCHING LOBSTER EGGS AND HOLDING FRY.

From a series of open-top jars the fry as hatched are discharged into a large rectangular tank.

REPORT OF THE SPECIAL COMMISSION FOR THE INVESTIGATION OF THE LOBSTER AND SOFT-SHELL CLAM.

I. GENERAL ACCOUNT OF THE LOBSTER AND CLAM INVESTIGATIONS.

By Hugh M. Smith.

DECLINE OF THE LOBSTER FISHERY.

The condition of the lobster fishery having become such as to occasion much concern on the part of fishermen and State authorities, the U. S. Commission of Fish and Fisheries in 1898 undertook special inquiries regarding the status and needs of this industry. At that time no branch of the American fisheries appeared to be more in need of intelligent treatment than the lobster fishery. Notwithstanding the existence of stringent protective laws and the regular prosecution of artificial propagation, the catch of lobsters along the entire coast was steadily diminishing; and it seemed evident that unless active measures were taken to increase the supply, the species would in a comparatively short time become practically extinct.

The decline of the lobster fishery may be attributed to three causes, namely, the relative infrequency of the breeding periods, the slow rate of growth, and reckless and illegal fishing.

The lobster does not ordinarily breed oftener than once in two years, and the intervals may be even longer. The eggs are carried by the female for ten or eleven months after extrusion, and when they finally hatch the young must pass through a long series of larval stages, during which they are subjected to many adverse conditions. If they survive the early critical period and establish themselves as young lobsters, it is probably four or five years before they become adults. Even under the most favorable conditions, the dangers are so great and the enemies are so numerous that only a small per cent reach maturity.

Overfishing and disregard for protective laws are mainly responsible for the present condition of affairs. In all the States it is legal to capture and kill at all times of the year, but all the States on the New England coast have enacted laws prohibiting the sale or possession of lobsters under certain lengths, and all prohibit the destruction of the

egg-bearing females. The strict enforcement of these laws is at present impossible, and it is safe to say that very few of the lobsters caught, no matter what their size or condition, are returned to the water.

STATISTICS OF THE LOBSTER FISHERY.

The Commission has, through its statistical inquiries, kept well informed as to the actual condition of the lobster fishery, and has published detailed statements of the quantity and value of the product at short intervals, beginning with 1880 and ending with 1902. In 1900 the lobster fishery gave employment to 4,348 persons; the vessels employed numbered 191 and were valued at $216,674; the number of boats used was 3,960, worth $261,918; the pots or traps set aggregated 208,563 and were valued at $224,111; and the shore, accessory, and other property connected with the industry was valued at $965,375, making a total investment of $1,668,060. The quantity of lobsters caught and sold was 15,767,741 pounds, for which the fishermen received $1,390,579.

Although the fishery is prosecuted from Maine to Delaware, inclusive, it is and always has been comparatively unimportant in New York, New Jersey, and Delaware; in these States in 1900 only 109 fishermen were engaged, and their catch was only 200,660 pounds, valued at $27,960. The lobster fishery in that section may therefore be omitted from further statistical consideration.

The New England lobster fishery reached its climax in 1889, during which year 30,449,603 pounds of lobsters were taken and sold for $833,736, as shown in the following table:

States.	Pounds.	Value.
Maine	25,001,351	$574,165
New Hampshire	137,175	6,415
Massachusetts	3,353,787	148,492
Rhode Island	456,000	21,565
Connecticut	1,501,290	83,099
Total	30,449,603	833,736

In 1902 the catch of lobsters in New England was 14,028,845 pounds, which sold for $1,271,962, the catch being apportioned as follows among the five States. Although the quantity of the output was 54 per cent less than in the banner year (1889) the value was 52½ per cent greater:

States.	Pounds.	Value.
Maine	11,435,739	$1,001,797
New Hampshire	128,463	14,863
Massachusetts	1,695,688	175,095
Rhode Island	397,305	39,488
Connecticut	371,650	40,719
Total	14,028,845	1,271,962

That the trend of the lobster fishery may be understood, there is shown herewith in condensed form the catch of the New England States for all the years for which the statistics are available, beginning with 1880. The plea has frequently been made during the past few years that there has been no real diminution of the lobster supply, and in proof thereof the financial condition of the lobster fishermen has been cited. It is true that the lobstermen are receiving more money for their lobsters than formerly, but in this fact lies one of the greatest dangers, for this state of affairs engenders indifference to the real condition and needs of the fishery.

Comparative statistics of the New England lobster catch.

Years.	Pounds.	Value.	Average price per pound.
1880	19,836,233	$473,341	$0.024
1887	28,627,600	784,238	.024
1888	27,640,282	808,842	.029
1889	30,449,603	833,736	.027
1892	23,409,927	1,035,501	.044
1898	14,661,808	1,276,967	.087
1900	15,567,081	1,362,619	.088
1902	14,028,845	1,271,962	.091

ARTIFICIAL HATCHING OF LOBSTERS.

The national government, through the U. S. Commission of Fish and Fisheries, cooperating with the States to maintain the lobster supply, has for many years been engaged in the artificial propagation of lobsters at its two marine stations on the Massachusetts coast, and many hundred millions have been hatched and planted. In recent years the work of gathering brood lobsters has been very thoroughly and systematically carried on, and each season during a period of several months immediately preceding the hatching time the entire coast of New England has been patrolled and practically every available egg-bearing lobster has been secured. This work has been conducted under an arrangement with several of the States, by which the lobstermen are permitted to retain the egg-bearing lobsters until an agent of the Commission shall have collected them, paying for them a little more than the market price. The "berried" lobsters are sent to the hatcheries and their eggs there removed, the old lobsters being afterwards taken back to their native localities and liberated. Another feature of this work has been the stationing of agents at points where lobsters are brought in from the Canadian provinces and the stripping of eggs therefrom, such collections some years amounting to many millions.

The extent of the lobster-cultural operations of the Commission from 1888, when the first practical work was done, to 1903, is shown in the following table. It will be seen that extensive operations have been

carried on only since 1894, and that notwithstanding greater efforts were made to obtain eggs, the output for the last five years of the decade was much less than for the first five:

Lobster fry planted.

Fiscal year.	Number.	Fiscal year.	Number.
1888	1,800,000	1897	115,606,065
1889	1,574,000	1898	95,234,000
1890	4,511,000	1899	108,463,000
1891	3,533,500	1900	77,166,000
1892	5,799,000	1901	60,879,000
1893	8,818,000	1902	81,020,000
1894	78,398,000	1903	68,631,000
1895	71,000,000		
1896	97,079,000	Total	879,511,565

While it can not be doubted that these efforts of the Government have been beneficial, they have not done more than retard the decline, and recently the lobster catch in certain sections has been so reduced that the supply of eggs for hatching purposes has greatly fallen off, and the conditions have become most serious.

Artificial hatching on a large scale is a comparatively simple matter, but the rearing of the young lobsters through their defenseless larval stages to the age when they are able to take care of themselves is a problem which has repeatedly been considered by fish-culturists and biologists, but appeared to present insurmountable difficulties, as all attempts to retain the fry in the hatchery for any length of time proved futile, the mortality being astonishingly rapid. The larvæ were therefore planted immediately after hatching.

It has been apparent to the Commission for years that the work of lobster cultivation would be vastly more effective if some method could be devised for rearing comparatively large numbers of the young, and, as this seemed to be the most practicable form of aid to the lobster fishery which could be rendered by the general government, it was determined to renew the experiments, this decision being influenced by some success in lobster rearing on a small scale achieved by Dr. H. C. Bumpus at the Woods Hole laboratory in 1898.

THE SOFT-SHELL CLAM.

Next to the lobster, this clam was the most important product of the shore fisheries demanding attention, and the Commission determined to acquire a more thorough knowledge of the breeding habits, time of sexual maturity, food, rate of growth, enemies, etc., as a necessary preliminary to the institution of measures for increasing the supply. During recent years the soft-shell clam has been rapidly diminishing in numbers on the New England coast, and prices for both food and bait clams have at times been very high. The scarcity has been par-

ticularly noteworthy in the more southern sections of the region, and grounds that had for years been productive had become depleted, so that in many places there was no longer a local source of supply.

The following statistics do not suggest an especially alarming condition in the fishery, but it must be remembered that the increased fishing population and the increased demand for clams between 1880 and 1902 should have resulted in a steady increase in the output.

Comparative statistics of the New England soft-clam yield.

States.	1880.		1889.		1902.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
Maine	318,383	$112,706	842,369	$200,761	497,132	$175,674
New Hampshire	17,960	8,980	300	150	3,000	3,000
Massachusetts	158,626	76,195	251,823	137,711	227,941	157,247
Rhode Island	53,960	48,564	33,375	32,475	26,490	32,514
Connecticut	75,000	38,000	26,360	24,900	22,460	26,743
Total	623,929	284,445	1,154,227	395,997	777,023	395,178

In the summer of 1898 Prof. J. L. Kellogg was engaged by the Commission to make a special study of the clam in Massachusetts and Rhode Island, and as a result of his inquiries it appeared feasible to develop a method of clam culture applicable to commercial conditions.

PERSONNEL AND PLANS OF THE SPECIAL COMMISSION.

It having been demonstrated that the ordinary funds available for the biological inquiries of the Commission were not ample to allow for the prosecution of the lobster and clam experiments on a sufficiently large scale, the Commissioner sought relief from Congress, and the urgent deficiency bill approved February 9, 1900, carried a special appropriation of $7,500 for this purpose.

The direction of the investigations and experiments was placed in the hands of a special commission, created by the Commissioner, consisting of Dr. H. C. Bumpus, chairman; Dr. H. M. Smith, secretary; Mr. W. de C. Ravenel, and Capt. E. E. Hahn. Most of the labor connected with the planning and supervision of the work devolved on Doctor Bumpus, to whom more than to any other member of the Commission is due the credit for the methods and outcome of the investigations.

Inasmuch as the general government had no control over the lobster and clam fisheries, it was apparent that the only aid which it was practicable for the Commission to give was (1) the study of obscure points in the life histories of the species, (2) the determination of the best methods of increasing the supply, (3) the dissemination of information on the foregoing topics among the fishing population, and (4) cultivation of the species. The work began in the spring of 1900 and

was actively pushed for three years. In the investigations and experiments the special commission had the valuable services of Dr. A. D. Mead, who, as a member of the Rhode Island Commission of Inland Fisheries, cooperated with the U. S. Fish Commission in the development of methods of clam culture and lobster rearing; of Prof. James L. Kellogg, of Williams College, who gave attention to the natural history of the clam and the establishment of experimental beds of planted clams; of Mr. George H. Sherwood, of Brown University, who was in immediate charge of the hatching and rearing of lobsters; and of Prof. Frederic P. Gorham, of Brown University, who studied the causes of mortality in artificially hatched lobster fry. Doctor Mead's work was carried on principally in Narragansett Bay; Professor Kellogg's at Woods Hole, Essex, and other points on the New England coast, and Mr. Sherwood's and Professor Gorham's at Woods Hole and Wickford. Dr. W. C. Kendall, assistant of the Commission, laid out a number of beds of planted clams on the shores of Casco Bay, Maine, and also experimented in the rearing of lobsters at Orrs Island, Maine.

RESULTS OF THE EXPERIMENTS, AND RECOMMENDATIONS.

In the reports of Mr. Sherwood, Professor Kellogg, and Professor Gorham, which follow, a detailed statement of the different lines of work and their outcome is given. Following is an epitome of the principal conclusions reached and work accomplished by the special commission:

Lobsters.—1. The hatching of lobsters as ordinarily conducted has had but little effect in arresting the decline in the fishery, owing in part to the fact that the larvæ must be planted soon after hatching and a very large percentage of them are quickly destroyed, and in part to the comparatively small number of fry liberated when the extent of the fishery and the area of the fishing grounds are considered.

2. The artificial rearing of lobsters until they have passed the most vulnerable period of their existence is one of the most vitally important steps that can be taken to maintain the supply, and one that is most appropriate for the general government to undertake.

3. While the rearing of lobsters presents difficulties, these are not insurmountable, and the special commission has developed a method which is applicable to economic conditions.

4. In the most favorable experiments upward of 50 per cent of the larvæ have been reared beyond the free-swimming stage, and there seems to be no reason to doubt that this record may be equaled or surpassed on a commercial scale as greater experience is gained.

Clams.—1. The supply of soft clams is susceptible of great increase, and the fishery can be placed on an enduring basis by the institution of cultural methods.

2. The special commission has developed a plan of clam culture which is very simple and effective, the pecuniary results being extraordinarily large.

3. Immense quantities of small, unmarketable clams are now lost each year, which, if utilized for planting purposes, on either barren or productive grounds, will increase the output of given sections many fold.

Among the measures which the special commission advocates for the betterment of the lobster and clam industries are the following:

1. The more extensive cultivation of the lobster; the extension of the work so as to save the eggs on lobsters taken throughout the year instead of only during a few months; and the rearing, to the lobsterling stage, of as much of the output of the hatcheries as possible.

2. The more effective enforcement of the existing lobster laws, and the enactment of additional legislation that may be found desirable for the protection of the lobster, such as the prohibition of the sale of all female lobsters for a term of years, and the proscription of the use of traps which will retain the undersized lobsters that may enter.

3. The dissemination among the lobster fishermen of authentic printed information showing the necessity for protecting the lobster and the injury that results to themselves from their failure to give cordial support to the State officials in enforcing restrictive laws.

4. The general adoption of clam planting on barren and depleted grounds.

5. The enactment of such legislation as will place clam culture on the same substantial basis as oyster culture.

II. EXPERIMENTS IN LOBSTER REARING.

By George H. Sherwood.

Under normal conditions the eggs of the lobster are laid in July and August, and, attached to the swimmerets along the lower side of the abdomen, are carried by the female until they hatch, the period being usually ten or eleven months, but depending somewhat upon the temperature of the water. The hatching season at Woods Hole is ordinarily from the middle of May until the 1st of July; on the Maine coast it is a week or two later. Not all the eggs develop with the same rapidity, so that the young are probably widely distributed as the mother moves about.

Immediately after hatching the fry are free-swimming, but, as has been many times described, they undergo a metamorphosis and become in the course of three or four weeks full-fledged lobsterlings, possessing pinching claws, a hard shell, and other anatomical characters of the adult. At this stage there is a remarkable transformation in their disposition and habits. They become combative and pugnacious if disturbed, but retreat from danger, hiding in the seaweed, under stones, or even burrowing in the sand, their color harmonizing with their surroundings; their movements are active and vigorous, and in many respects they are capable of taking care of themselves.

Each of the three stages of early development is completed with the molting or shedding of the skin or shell. This process continues throughout the life of the lobster, becoming more infrequent, however, with increased age. During the larval stages, especially, it is a severe drain on the vitality, for a time leaving the fry exhausted and almost entirely helpless. These early metamorphoses are the most critical period in the life of the lobster, and the mortality at this time limits the effectiveness of planting newly hatched fry; moreover, it is during this enfeebled condition that the natural enemies are most active.

When the young lobster emerges from the egg it bears little resemblance to the adult either in external form or in habit. It swims aimlessly or floats at the surface of the water, occasionally seizes a particle of food, but apparently has no sense of danger. Its bright colors and activity render it conspicuous to the numerous predatory fishes, and currents carry it far from its native waters. It is safe to

say that not more than one in a thousand reaches maturity. If the fry are retained in artificial inclosures some of the natural enemies are eliminated, but new agents of destruction arise.

Many years ago the cannibalistic tendencies of confined larvæ were noted, and were found to be especially strong during the molting periods. The young possess an almost insatiable appetite, and devour all weaker brethren within reach. From the exhaustion incident to molting, they settle to the bottom of the inclosure, collecting in masses at the lowest points, and the mortality from cannibalism and suffocation is astonishing. This loss is also materially increased by the attack of a vegetable growth (diatomaceous) which infests even the most vigorous and healthy fry. They are so thickly coated with these diatoms as to look like balls of chenille; they become logy and inactive, refuse food, and eventually settle to the bottom and die.

It is evident, then, that the mere hatching and distributing of a large number of fry can have little if any effect toward reestablishing the waning lobster industry. If, however, it were possible to carry the young lobsters through the critical larval periods to the stage when they assume the habits of the adult, and thus are able to protect themselves, there is reason to believe that a much larger percentage would reach maturity. It was, then, to the difficult problem of rearing the fry through three molts to the lobsterling stage that the special commission first turned its attention. In 1898 Doctor Bumpus began a series of experiments which covered a period of two years, and considerable preliminary work had been done when the special commission took up the problem. The difficulties referred to above were thoroughly understood. It should be remembered, also, that the hatching season covers at most a period of only eight weeks, and frequently three weeks' time or more is necessary to test the practicability of any experiments. Two failures mean the loss of a season.

In the experiments of 1898 and 1899 a variety of inclosures was tried—cars of wood and cars of wire netting, some with gravel bottom and some containing sand, glass aquaria and aquaria of stone, balanced aquaria and aquaria with automatic plungers, deep and shallow dishes of earthenware and glass, cars made of scrim cloth and deeply submerged, others of scrim and floating, and natural pools, both large and small, in which the tide rose and fell. These various receptacles were located in many places in the vicinity of Woods Hole; some were placed in the hatchery and fed by water from the pumps, others were placed in the "pools" and waters adjacent to the station, some in Eel Pond, some near Ram Island, and some even at Hadley Harbor, where there could be no question of the purity of the water. Neither the nature nor location of the receptacle, however, nor the kind of food, changed the course and outcome of the experiments. The fry seemed to thrive until about the time for the

first molt; then there was a heavy mortality, which occurred again at the second and third molts. Rarely could more than half a dozen lobsterlings be obtained, whether the original number of fry was a score or a thousand.

Toward the close of 1899 there was a receptacle devised which promised more satisfactory results than all the others. This was a rectangular bag 8 feet long, 4 feet wide, and 4 feet deep, made of cotton scrim. The top of the bag was attached to a wooden frame floating on the surface of the water, while the bottom was kept submerged by means of sinkers. Since the bag was merely suspended in the frame, and its sides were not rigid, the fluctuations in the currents, due to tide or wind, kept the sides waving continuously back and forth with a kind of undulating motion. This motion of the bag created circulation and prevented the fry from sinking to the bottom. With only three of these bags about 100 lobsterlings were reared in 1899.

THE FIRST SEASON'S WORK (1900).

It had frequently been suggested, and the repeated failures in previous years seemed to indicate, that the environmental conditions at Woods Hole were not at all favorable for the development of young lobsters. To test the correctness of this view and to discover if possible a locality better suited to the needs of the fry, it was decided to try experiments with the same apparatus at various other localities on the New England coast as well as Woods Hole. The places selected were Orrs Island, on the Maine coast; Annisquam River, near Gloucester, Mass., and Wickford, R. I., on Narragansett Bay.

EXPERIMENTS AT WOODS HOLE.

Since the floating scrim bag had proved the most practical inclosure and promised interesting results, the special commission decided to adopt it for the first investigations in 1900, and early in May preparation for the work was begun at the Woods Hole station. Several large floats or rafts were constructed of heavy planking and buoyed with casks. Each float was about 16 by 12 feet, and was capable of holding 6 bags of the standard size (8 by 4 by 4 feet). Later larger bags were tried, some 8 by 6 by 4 feet and others 16 by 12 by 4 feet, but on the whole the small bags gave the most satisfaction. All the bags were made of the coarsely woven cotton scrim above mentioned.

The first experiment was started May 23, when 950 young (the first of the season) were taken from the hatchery and placed in the bag moored in the inner basin at the station. These were fed twice a day for five days with surface towings, which consisted mostly of copepods.[a] This did not prove a practical food, however, as it was often

[a] It was believed from the work in 1899 that the plankton was the natural food of the young lobster, and that it was the solution of the food question.

impossible to procure sufficient quantities. After the failure of the plankton supply, lobster liver was used as food and continued until the close of the experiments.

The fry began to molt on May 28, and on June 1, or ten days from date of hatching, the majority of those alive were in the second stage; but the mortality was considerable, only 486, or about one-half the original number, having survived. On June 5, 1 had reached the third stage, but it was sixteen days from the date of hatching before a majority had passed the second molt, and even greater mortality occurred during this period than during the first, only 36 passing successfully. Of these, 19, or 2 per cent of the original number, reached the fourth stage, their age at this time being twenty-five days. This percentage, small as it is, was encouraging, although it was the largest percentage secured at Woods Hole by the methods of 1900.

TABLE I.—*Details of lobster-rearing experiments at Woods Hole in 1900.* [a]

Experiment No.	Date of hatching.	Date of beginning of experiment.	Number of fry received.	Location of experiment.	Food.	Condition of fry when received.	First of second stage appeared.	Majority of second stage appeared.	First of third stage appeared.	Majority of third stage appeared.	First of fourth stage appeared.	Majority of fourth stage appeared.	Duration of first 3 stages.	Average temperature between hatching and fourth stage.	Total number reaching fourth stage.	Remarks.
													Days.	° *F.*		
1	May 20–23.	May 23	[b] 950	Basin, Woods Hole Station.	Plankton and lobster liver.	Good..	May 28	June 1	June 5	June 7	June 12	(?)	25	60.	19	486 became IIs; 36 became IIIs.
2	May 25....	May 25	[c] 10,000	Hadley Harbor.	.....do........	...do...	June 4	June 6	June 8	June 10	(?)	June 20	25	59.7	15	Diatoms became very abundant. On June 7 there were 25 Is, 236 IIs, by actual count.
3	May 26–27.	May 28	30,000	Basin, Woods Hole Station.	Lobster liver.	...do...	...do...	...do...	June 9	(?)	(?)	(?)	(?)	(?)	(?)	On June 9 there were only 105 IIs and 5 IIIs, by actual count.
4	May 29....	May 30	[c] 2,000	.....do..........	.....do........	...do...	June 5	...do...	...do...	(?)	(?)	June 18	21	59.5	50	Diatoms abundant; 350 lobsters alive June 9.
5	....do.....	May 31	[c] 2,500	Hadley Harbor.	.....do........	Fair...	June 4	...do...	(?)	(?)	(?)	June 20	23	59.8	3	All IIs on June 9. Not visited from June 10 to 19.
6	June 6....	June 7	[b] 1,000	.....do..........	.....do........	Picked fry.	(?)	(?)	(?)	(?)	(?)	(?)	(?)	(?)	(?)	Fed only once. Not visited from June 10 to 19. Not one in bag on June 20.
7	June 1....	June 2	[b] 1,000	Basin, Woods Hole Station.	Plankton only.	...do...	June 7	June 9	(?)	(?)	(?)	(?)	(?)	(?)	(?)	June 8, 150 alive—about half IIs. June 9, 73 alive; all IIs. June 11, experiment discontinued.
8	....do.....	...do...	[b] 1,000	.....do..........	Lobster liver only.	...do...	...do...	...do...	(?)	(?)	(?)	(?)	(?)	(?)	(?)	June 8, 200 alive; about half IIs. June 9, 100 alive; all IIs. June 11, experiment discontinued.

[a] In the laboratory the fry in these various stages have been designated by the Roman numerals I, II, III, and IV, or as first, second, third, and fourth stages.
[b] Counted. [c] Estimated.

Average time from hatching to fourth stage=23+days.

From the foregoing table it will be seen that although the floating scrim bags were in many respects superior to other inclosures, they did not yield results of particular importance. It was proved, however, that as long as there was a current in the water the bags worked well, though at slack water or during calm weather, when the sides of the bag were motionless, the fry sank to the bottom, collected in masses, and perished by the thousand. Calms of only a few hours' duration were sufficient to cause the failure of many experiments.

EXPERIMENTS AT ORRS ISLAND, ME.

The work on the Maine coast was in immediate charge of Dr. W. C. Kendall, who began his work at Orrs Island, in Casco Bay, in the latter part of June. Floats were constructed and equipped with scrim bags like those used at Woods Hole. They were anchored in a "gutter" between Orrs Island and Baileys Island, where the rising tide brought in cold clear water from the open sea. It was believed that this would prove an admirable place for lobster culture, as the water was free from all contamination.

On June 23 a shipment of 500,000 fry was received through Capt. E. E. Hahn from the Gloucester hatchery. They were transported from Gloucester in the well of the schooner *Grampus* and arrived in good condition. The fry were distributed to three small bags and regularly fed with finely chopped lobster liver. Only 20 became lobsterlings. A second shipment of 500,000 was received about the middle of the season. They were nursed in one of the large bags (16 by 12 feet), and 59 finally reached the fourth stage. The work was closed August 6.

The history of these experiments is practically a repetition of that at Woods Hole. The fry seemed to do very well for a few days, then died in great numbers. In one bag containing 1,245 lobsters, actually counted, 75 per cent died the first week. Diatoms were abundant and infested all the young.

EXPERIMENTS AT ANNISQUAM, MASS.

A plant consisting of a float and large bag was constructed on the Annisquam River near Annisquam, and on July 6 about 100,000 fry were brought from the Gloucester hatchery in transportation cans. Both clam and lobster liver were used as food. During a gale on July 11 the bag was blown out of the water and most of the lobsters were lost, but with the few that were saved the experiment was continued until July 14.

The death rate was about the same as in the other localities, but diatoms were less abundant. The growth of the fry was more rapid than at either Orrs Island or Woods Hole. The first second-stage

lobster appeared on the fifth day from date of hatching, and three reached the lobsterling stage on the tenth day.

The water at Annisquam is very shallow and is much warmer than in the open ocean. The temperature during the experiments ranged from 64° to 76° F.

EXPERIMENTS AT WICKFORD, R. I.

The Rhode Island Commission of Inland Fisheries generously accorded the use of its new floating laboratory at Wickford, R. I., for experiments at this point, and Dr. A. D. Mead, biologist of the State commission, gave special attention to the work. Much credit is due Doctor Mead for his energy and interest in the investigations and for the magnificent results obtained.

All the lobster fry used were transported on the steamer *Phalarope* from the hatchery at Woods Hole. The apparatus employed in rearing was the same as at Woods Hole and elsewhere—namely, scrim bags and floats. The first shipment, estimated at 2,000 fry, was received from the Woods Hole hatchery on June 1 and placed in small bags. They were fed with lobster liver and soft parts of clam, and grew rapidly. Although many died during a calm on June 3, 320 reached the fourth stage. The average interval before the appearance of the lobsterling in this experiment was 16 days, while at Woods Hole the average time was never less than 22 days.

TABLE II.—*Details of lobster-rearing experiments at Wickford in 1900.*

Experiment number.	Date of hatching.	Date received.	Number received.[a]	Food.	Condition when received.	First of second stage appeared.	Majority in second stage appeared.	First in third stage appeared.	Majority in third stage appeared.	First in fourth stage appeared.	Majority in fourth stage appeared.	Average time from hatching to fourth stage.	Average temperature between hatching and fourth stage.	Total number of fourth stage.	Remarks.
													°F.		
1	May 31	June 1	2,000	Lobster liver, clams.	Good		June 6	June 9		June 13	June 16	16 days	65	320	Calm on June 3. Bags changed at third stage; killed many.
2	June 8	June 9	2,000	Clams	do		June 14?		June 19?	June 21	June 23	15 days	66	212	On June 21, 230 in third and 77 in fourth stage.
3	June 10	June 11	30,000?	do	Fair				do	June 22	June 24	13 days	68	598	Many dead when received. Last of third stage molted June 26—16 days.
4		June 14	50,000?	do	Many dead		June 19	June 21[b]		June 26[c]	June 27	do	68	186	Brought from Woods Hole packed in ice.
5		June 18	70,000?	do	Very poor	June 21			June 24[d]	June 27	July 2	do	69	522	On June 24 big bag was very foul, and 1,420 of second and third stages were put in fresh small bag. These yielded 339 at fourth stage.
6	June 22	June 22	5,000	Lobster liver, clams.	Excellent					July 2		10 days	70	2	On June 23 estimated 1,000 dead from stagnation. On July 2 nearly all dead.
7		June 25	20,000?	Clams	Good		June 29		July 4	July 5	July 8	12 days	72	119	Those put in big bag nearly all died. Only 2 reached fourth stage.
8		June 27	15,000	do					do		July 9	do	72	350	Injured by violent wind, June 28.
9		July 2								July 9	July 12	10 days	72	748	On July 11—9 days—there were 165 at fourth stage. Stirred constantly from July 6 to July 12. First of fourth stage in 7 days.
10		July 5		Clams	Poor				July 10[e]	July 11	July 14	9 days	72	319	All those in car died from crowding together. Bags stirred continuously. Hole in one bag let many out.
11		July 11		do	Very poor[f]				July 16	July 4	July 23	11 days	73	49	This set was very poor, and received little care.

[a] Estimate. [b] 10 per cent. [c] 25 per cent. [d] Fresh bag. [e] Very clean. [f] Mostly dead.

Average time from hatching to fourth stage = 12 + days.
Total number of fourth stage = 3,425.

The short season allowed time enough for only eleven experiments, but with the interesting result that 3,425 fry were reared to the lobsterling stage. Compared with the meager results of other experiments, the aggregate of which was less than 400 lobsterlings, these figures were most satisfactory.

Many of the usual difficulties of the problem were encountered at Wickford, but in a lesser degree. The mortality at the molting time, particularly the first and second molt, was considerable. Cannibalism was noticeable, especially where large numbers were confined in small inclosures. The majority of the fry became infested with a profuse growth of diatoms, and it was necessary to change and clean the bags frequently, sometimes as often as two or three times in a week. Nevertheless, the facilities of the Wickford station, together with the physical and biological conditions, seemed to render the place especially suitable for lobster culture. The floating laboratory of the State commission was equipped not only with scientific instruments and work tables, but with sleeping quarters for two or three persons. Thus, by separating the men into watches, it was possible to keep the fry under continuous observation, the importance of which was later proved. The natural condition of the water was also favorable to the young lobsters. Mill Cove, where the plant was located, is a small inlet on the west side of Narragansett Bay, about 9 miles from Newport and the open sea. It is practically landlocked, and the severest storms have little effect. The water is considerably warmer, and its density somewhat lower, than in the vicinity of Woods Hole. This higher temperature of the water, together with its protected location, makes Mill Cove and many other portions of Narragansett Bay natural nurseries and feeding grounds for hosts of marine organisms, and at certain seasons of the year the waters are literally alive with millions of larvæ and eggs of clams, oysters, starfish, etc. As such organisms probably constitute the natural food of young lobsters, the importance of a rich plankton is readily understood.

Doctor Mead's continued observation of the fry led him to the conclusion that the secret of rearing young lobsters was constant agitation of the water, so that the fry could not gather on the bottom. In the scrim bags this condition existed only when there was a light wind or gentle current. High winds frequently blew the bags out of the water, and a strong current usually forced the fry against the sides or bottom of the bag, and the results were as disastrous as during the calm.

To test the correctness of his conclusion Doctor Mead decided to stir the water continuously and note the result. For this purpose the working force in the laboratory was divided into watches, and from July 6 to July 12 the water in experiments No. 9 and No. 12, Table II, was stirred with an oar day and night. The results were convincing,

experiment No. 9 alone yielding 748 lobsters, or more than had been reared in the combined efforts at all other localities. Unfortunately the close of the season interrupted further experiments along this line.

SUMMARY OF THE RESULTS OF THE WORK OF 1900.

The first year's work of the special commission developed the following facts:

1. Conditions at Woods Hole, whether near the hatchery or at Hadley Harbor, were unfavorble, and the floating scrim bags proved in this locality as inadequate for practical lobster culture as other inclosures had proved.

2. Environmental conditions at Orrs Island and Gloucester were not more suitable for the growth of young lobsters than at Woods Hole.

3. Lobster fry thrive much better at Wickford than at Woods Hole, Orrs Island, or Gloucester; just why is not fully known, but there can be little doubt that the higher temperature of the water, its relative calmness, and the great abundance of natural food were prime factors. The rate of growth also is a matter of great importance, for, other things being equal, the shorter the critical period the greater the chance of survival. For example, and as already stated, at all the stations the fry became covered with diatoms, which are both directly and indirectly responsible for a great amount of the mortality. When the shell or skin is shed, the fry get rid of this pest, and are clean until a second infection. Hence if the young lobsters grow rapidly they shed before the diatoms become a serious incumbrance. This was demonstrated at Wickford, where the average time required for a young lobster to reach the lobsterling stage was 12 days instead of 22, as at Woods Hole.

4. The temperature of the water, as is to be expected, has a marked influence on the rate of growth. The coldest water was found at Orrs Island, ranging from 57° to 63° F., and the critical period was from 25 to 26 days. The temperature at Woods Hole was only slightly higher, and the fry developed in from 22 to 25 days. At Wickford the water averaged 5° to 10° higher than at Woods Hole, and the average developmental period was only 12 days. In the first experiments the duration of the first three stages was 16 days, average temperature 65° F.; in experiment No. 10, with an average temperature of 72° F., it was 9 days. (See Table II.) At Annisquam the water was very warm, sometimes reaching 76°, and lobsterlings were obtained in 10 days.

5. Proper food and feeding is a problem in itself. Naturally the lobster liver used in the Woods Hole, Orrs Island, and Annisquam experiments was not practicable, and although the fry seemed to thrive on the soft clam, this food sank to the bottom, where it decayed and

fouled the water. The subject of food and the method of feeding will be discussed later.

6. Constant agitation of the water is the most important factor in lobster rearing, and Doctor Mead's fortunate discovery of this fact marked the course of future experiments.

WORK DURING 1901.

Since it appeared from the investigations of 1900 that young lobsters thrive better at Wickford than at other localities in New England, the special commission decided to abandon for the season its other stations and concentrate its energies at Wickford. Again the Rhode Island Commission of Inland Fisheries most cordially cooperated with the government, offered the use of its floating laboratory with its equipment, and facilitated the carrying out of the experiments in every way possible.

The application of the most important result of the preceding year (1900) was the first consideration. Constant agitation of the water, very different, however, from that obtained in the McDonald hatching jar, was a prime necessity, and the commission decided to provide some mechanical device to replace the laborious and unsatisfactory method of stirring used in the test experiments.

The last week in April the writer went to Wickford for the purpose of devising and constructing an apparatus suitable for the work. Some of the mechanical difficulties were peculiar, and of the devices suggested some modification of a propeller movement seemed most feasible. The floating laboratory or house boat proved an admirable place for constructing the apparatus. The house boat, with a house at each end, was a kind of catamaran, consisting of two large pontoons, 58 feet long and 4 feet wide, placed 8 feet apart. The pontoons and the two houses inclose a "well" 8 feet wide and about 25 feet long. The boat possessed the necessary rigidity to protect the apparatus from the effects of storm or wind, while the houses furnished shelter for the engine and attendants.

The rearing device, a detailed description of which is given below, consisted of a series of cylindrical scrim bags supported in a wooden frame. In each bag, near the bottom, was placed a two-bladed fan or propeller, the vertical shaft of which was connected with a horizontal shaft on the deck of the house boat. This shaft was geared to a gasoline engine, which furnished the power. Rotation of the fans created a current of water from the bottom of the bag toward the top.

The apparatus may be described as consisting of two parts:

(*a*) The car or bag for holding the fry, with its supporting framework;

(*b*) The mechanism (propeller, belts, shafting, etc.) for stirring the water.

(A) THE CAR OR BAG.

The requirements for the inclosure were as follows:

1. It should allow for abundant circulation of the water from the outside.
2. It should have as few corners and pockets as possible.
3. It should be fastened so that it could be readily changed and cleaned.
4. It should be rigid enough to keep its walls out of the propeller.

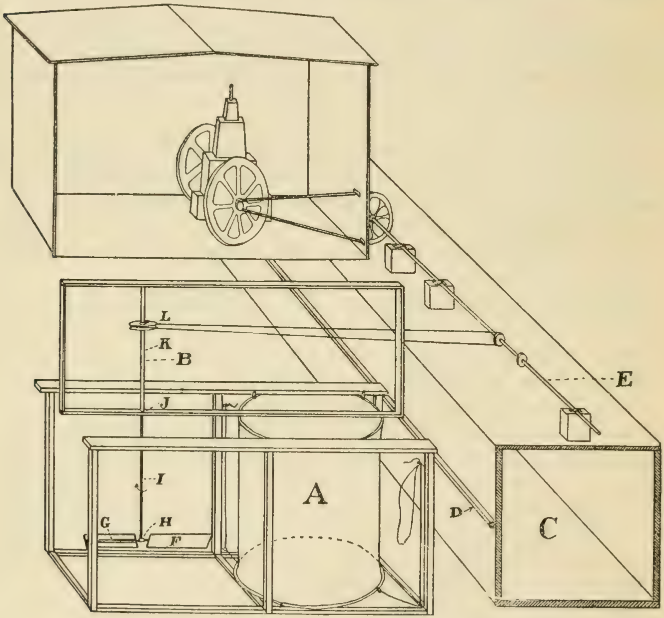
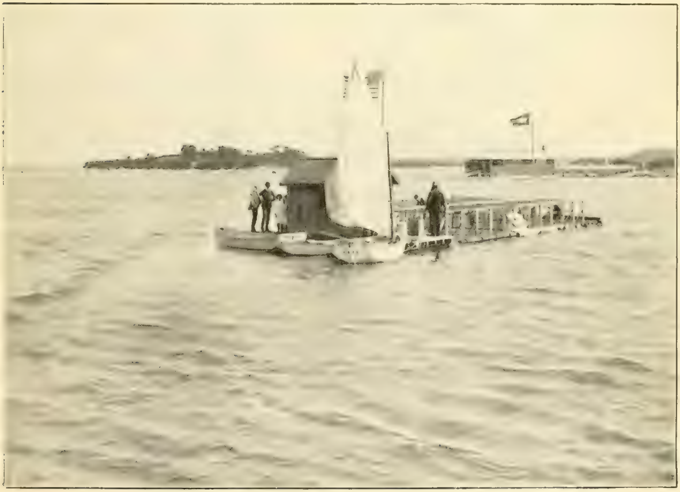


Diagram of apparatus used in hatching and rearing lobsters.

Material.—Galvanized-wire netting was first suggested as the most suitable material for the car. This was soon abandoned because of its tendency to break, and because it was feared that the current of water might carry the young lobsters against the rigid metal and fatally injure them. The cotton scrim, such as was used in the experiments of last year, was considered more serviceable, as it would permit free circulation, was comparatively inexpensive, and could be easily cleaned. The only difficulty connected with its use was keeping the cloth free from the propeller blade.

FLOATING LABORATORY OF THE RHODE ISLAND COMMISSION OF INLAND FISHERIES AT WICKFORD, R. I., WHERE EXPERIMENTS OF 1901 WERE CONDUCTED.



REARING PLANT USED IN EXPERIMENTS IN 1902, AT WOODS HOLE.

Size and shape of bag.—From this material was made a cylindrical bag, a little more than 3 feet in diameter and 40 inches deep, the latter being the width of the goods as it comes from the factory. By making a sack this size, it was necessary to have only two seams, one up the side, the other around the bottom of the bag. This did away with the pockets and corners which were so troublesome in the square bags the year before. Along the bottom seam on the outside of the bag was sewed a piece of drilling 4 inches wide, and this was turned over a wooden hoop (child's rolling hoop), which was a little greater in diameter than the diameter of the bag. The hoop kept the bottom taut, and also furnished a strong attachment for the ropes necessary to hold the bag in place. In a like manner another hoop kept the mouth of the bag open.

The support of the bag.—A cleat runs lengthwise on the inside wall of each pontoon 6 inches above the water, and at intervals of 4 feet on the cleats 2 by 6 inch planks were laid across the well and securely fastened. To the under side of each plank were nailed three posts 4 feet long, one at each end and one in the middle (see diagram). To make the frame still stronger, the submerged free ends of the posts hanging from consecutive planks were joined together by scantling pieces. Brass screw eyes were fixed in the bottom of each post.

The bag was held in the frame just as the bowl or pocket of a fish pound is secured. The top was fastened with strings to the planks above (see diagram). The bottom was drawn down and the sides of the bag stretched by means of "down-hauls", or ropes, which roved through the screw eyes in the post. In this manner the bag was held so securely that there was little danger of the wind or tide carrying the cloth into the propeller, which was suspended in it. At the same time it was a very simple matter to remove the bag whenever desired.

(B) THE STIRRING MECHANISM.

To keep the fry from settling to the bottom of the bag, a simple two-bladed fan, similar to those so often seen in restaurants for circulating air, was suspended in the bag and revolved slowly. The blades, F, of the fan (see diagram) were 14 inches long and 5 inches wide, made of cypress, and screwed firmly to a piece of maple, G, one end of which fitted snugly into the $\frac{3}{8}$-inch tee, H. The blades were then set at angles and opposite each other. The shaft of the fan was made of two pieces of galvanized gas pipe 3 feet long and of different sizes. One end of the lower half ($\frac{3}{8}$-inch pipe) was screwed into the tee and the other was joined to the upper half ($\frac{3}{4}$-inch pipe) by a reducing coupling. The whole was then suspended in the bag by means of some 2 by 3 inch pieces, as shown in the diagram, the reducing coupling serving as the bearing for the shaft. To make the fan turn more easily, an iron

washer was sunk in the frame, and the coupling revolved on this. When the fan was in position, the blades were about 6 inches from the bottom and about the same distance from the sides of the bag. An 8-inch galvanized sheave, L, was put on the upper end of the shaft and fastened with a set screw. A belt from the main power shaft, E, on one of the pontoons, to this wheel transmitted the power for revolving the shaft. It was found that the strength of the current could easily be controlled by changing the angle of the blades.

The power for rotating the fan was supplied by a Fairbanks & Morse gasoline engine of 2½ horsepower, which was placed in one of the houses of the boat and connected by a belt with a large driving wheel on the main power shaft. This shaft was set up on the deck of one pontoon and extended the length of the well. At intervals on the shaft corresponding to the positions of the fans, small 3½-inch wheels were fastened with set screws. Each of these wheels was connected with the driving wheel of the fan by a rope belt.

The most troublesome part of the mechanism was the belting. All the machinery except the engine was exposed to the weather. No belting was found that would stand the weather and not stretch and shrink, and finally a loose-laid 1-inch rope called "Russia purse line" was used, as this seemed least affected by dampness. The annoyance from the slacking and shrinking was overcome in two ways. The belts could be lengthened or shortened several inches by moving the sheave up or down on the shaft of the fan; when this was not sufficient they were run over spools which were fastened to the supporting posts and which acted as third pulley. The fans revolved at the rate of 15 to 20 turns per minute, and produced a current which took all the material from the bottom, but still allowed comparatively uniform distribution of the fry in the upper part of the bag.

OBJECT OF THE WORK.

The chief object of the investigations in 1901 was not to see how large a number of lobsterlings could be reared, but to determine how large a percentage could be carried through successfully to the fourth stage by means of stirring the water. From the data thus secured the value of the principle could be judged and the wisdom of its application on a large scale determined. Observations were also continued on the habits of the fry in the several stages, the effect of temperature and light, food, and the best method of feeding.

Fourteen experiments were made in all, of which two were total or partial failures through accidents to the apparatus, while in the last experiment the stirring was not continued after the fifth day. The complete data of the experiments are given in Table III. Nearly 9,000 lobsterlings were obtained and either released in the adjacent waters

or kept in jars for future observation. In no instance, excluding the experiments interrupted by accident, was the percentage of fry reaching the lobsterling stage less than 16.32, while in one experiment it was 50.60. The average percentage was 27.25.

TABLE III.—*Details of lobster-rearing experiments in 1901.*

Experiment No.	Date of hatching.	Date of beginning experiment.	Number placed in bag.	Age when first fourth stage appeared.	Average age when fourth stage appeared.	Number in fourth stage.	Reared to fourth stage.	Remarks.
							Per cent.	
1	June 12	June 14		11 days	12 days	1,418		These were not counted in the early stage, the lot being stock for other experiments.
2	do	June 12	5,000		12–13 days	1,110	20.22	Fry taken from lot No. 1.
3	June 13	June 13			13 days	1,336		
4	June 10	June 11	1,000	13 days	15 days	347	34.70	Hatched at Woods Hole and transferred.
5	June 13–15	June 14	2,500	do	do	408	16.32	
6	do	June 15	2,500	do	do	436	17.44	
7	do	June 17	2,500	do	do	1,004	40.16	These were from 2 to 3 days old when experiment began.
8	June 20	June 24	5,000					Experiment interrupted by an accident.
9	do	do	5,000	10 days	11 days	971	19.42	These were 4 days old when experiment began; the percentage would have been higher if IVs had been promptly removed as soon as hatched.
10	do	June 25	5,000	do	do	947	18.94	These were 5 days old when experiment began.
11	June 26 or 27	June 28				476		From Woods Hole.
12	June 26	do	2,500	9 days	10 days	19	.76	The experiment a failure through accident to bag.
13	do	do	1,000	do	do	506	50.60	From Woods Hole.
14	July 1 (?)	July 2	1,134			95	8.38	As this was the last lot and in poor condition, the agitation was not continued after the first 5 days.
	Total					8,974		

With the exception of experiments No. 4, 11, and 13, all of the fry were hatched at Wickford.

The figures given in Table III are based on actual count. Compared with the experiments of 1900, which represent the best previous efforts, the results of the stirring apparatus were certainly satisfactory. If with this comparatively simple and inexpensive device it is possible to plant as lobsterlings 20 per cent of the product of the hatchery, there is every reason to believe that much could be accomplished for a declining industry.

When the season's work was planned, it was the intention to transport fry for the experiments from the Woods Hole hatchery by boat, as had been done in 1900. Circumstances prevented the detail of a proper boat for this work, however, and it was necessary to ship the fry in tin transportation cans by rail, a journey which occupied five or six hours and left the fry which survived the trip in a weakened and precarious condition. Transportation thus became a serious question, and it was decided to collect egg-bearing female lobsters and attempt

hatching in the rearing apparatus. Several "berried lobsters" were brought from Newport, the eggs stripped in the usual manner and placed in one of the scrim cylinders, and the propeller was adjusted to create a current strong enough to lift the eggs from the bottom.

The results surpassed our expectations, for although constructed primarily for rearing and brooding the fry, the stirring apparatus proved admirably adapted for hatching the eggs, and as a hatching device merely was decidedly superior to the McDonald hatching jar. In the latter the eggs and young lobsters are subjected to a protracted mauling. If examined under a microscope, many are found to be mutilated, appendages are missing, a gill torn off, or an eye indented. Such a lobster must be seriously handicapped from the very beginning. The fry hatched in the bags are not subject to such violent treatment, are probably stronger and more healthy, and their chances of living are materially increased. The bags were of a convenient size and could easily be removed and cleaned. To separate the fry from the eggs all that was necessary was to stop the fan, when the eggs sank quickly to the bottom, leaving the active fry swimming near the surface. These could be easily removed, and expeditiously transferred to the rearing bags.

SUMMARY OF RESULTS OF THE WORK OF 1901.

1. The value of artificial agitation of the water was established.
2. It was proved by experiments that from 16 to 50 per cent of the fry could be carried through three molts.
3. It was shown that apparatus of large capacity could be built and maintained at small expense.
4. The rearing apparatus was found to be also a most efficient hatching apparatus, far superior to the McDonald or Chester jars.
5. Data for guidance of future experiments were secured:

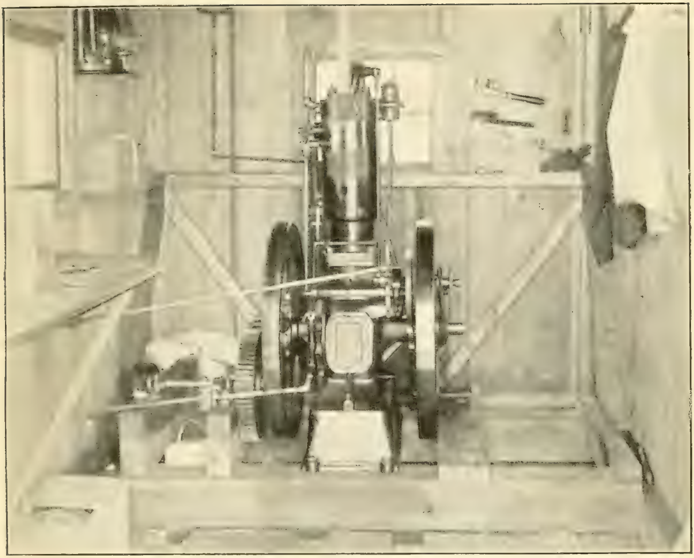
(*a*) It is important to remove the lobsterlings from the brooding bags as fast as they appear. Overcrowding the bags with fry does not give good results.

(*b*) Careful attention must be given to the kind and amount of food.

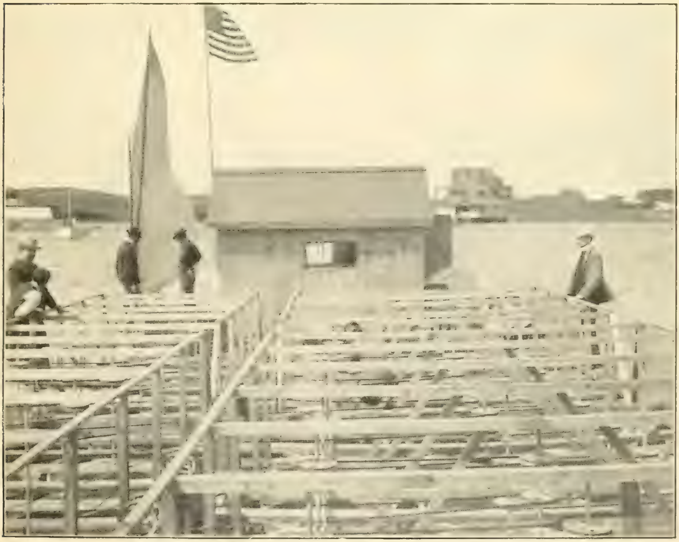
WORK DURING 1902.

Before closing its work, the special commission wished to learn, if possible, whether agitation of the water would prove equally successful in other localities. It was also desired to make experiments on a larger scale in order to test the adaptability of the apparatus.

Although, on account of the greater abundance of lobsters, several places on the Maine coast or near the Gloucester hatchery seemed more favorable for the location of a plant, it was decided to establish it at Woods Hole, for the following reasons: (1) Owing to the prox-



INTERIOR OF ENGINE ROOM OF PLANT USED IN 1902, AT WOODS HOLE.



VIEW OF REARING PLANT AT WOODS HOLE, SHOWING METHOD OF TRANSMITTING POWER TO THE FANS.

imity of the machine shops and scientific laboratory of the Woods Hole station, the cost of construction and maintenance would be less than elsewhere. (2) The physical conditions were better understood there than elsewhere. (3) It seemed probable that the temperature conditions would more nearly approach those at Wickford than would be the case farther north. (4) It was desirable to compare the results of these experiments directly with results obtained in earlier experiments. (5) It seemed desirable to test what several investigators had frequently claimed, and what our previous experiments seemed to indicate, namely, that the biological conditions at Woods Hole were extremely unfavorable for the development of young lobsters.

The investigations of 1902 were placed in charge of the writer, who began the work of constructing apparatus the last week of April.

THE APPARATUS.

In order that the comparison of results might be more satisfactory, it was decided to employ essentially the same stirring mechanism and bags as were used at Wickford in 1901.

The plant consisted of a strong raft or float supporting 60 cylindrical scrim bags, in which were suspended two-bladed propellers, as at Wickford, and these were rotated by a small gasoline engine. On the stern of the raft was built a small house which protected the engine and served as a laboratory and shelter for the attendants.

The construction of the bag and the propellers was the same as in the Wickford experiments. The raft was made by fastening together two spars 50 feet long and 2 feet in diameter, with four 6 by 6 timbers 25 feet long. To give added strength and buoyancy, a third spar was securely bolted between and parallel to the others, but a little to one side of the center of the raft.

Thus the three spars, the platform, and the forward timber inclosed two "wells" of unequal size, one 40 feet by 7½ feet, the other 40 feet by 11½ feet. These wells were cut up into a number of smaller ones by planks placed across the spars at intervals of 3½ feet. To the under side of these planks were nailed two posts of 2 by 3 stock 4 feet in length, and a third piece of 2 by 3 as long as the width of the "well," connected the lower ends of the posts. The planks and posts were securely spiked to the spars and formed a firm and rigid support for the bag. There was space for 60 bags, or five times as many as had been used at Wickford. Across the stern of the raft was built a plank platform 25 by 10 feet, which served for support of the engines and the house.

The power for rotating the fans was furnished by a Fairbanks & Morse 2½-horsepower gasoline engine, as at Wickford, and was transmitted to the main shaft, which ran the length of the middle spar of the raft, by a system of gears which reduced the speed to the required

revolutions. From the main shaft the power was distributed to the individual fans by belts, in a manner not materially different from that described for the Wickford apparatus.

The rearing plant completed, the engine was started June 3, and continued to run day and night until the close of the experiments on July 19. In order to have water free from contamination, the plant was removed from the "pool" at the station and anchored in the edge of the tide near Devils Foot Island. The depth of the water was 15 feet, and it was thought that the current through the Hole would bring a large amount of natural food into the bag. The current was too strong, however, and the dirt and débris suspended in the water were deposited on the bag and soon prevented circulation. Therefore, on June 9 the plant was towed to the head of Great Harbor and anchored in 8 or 10 feet of water. The conditions proving more favorable here, where they more nearly approached those at Wickford, the apparatus was kept at this place until the close of the season.

The efforts to rear and plant a large number of lobsters were not as successful as had been hoped; nevertheless, fully 4,000 were brought to the fourth stage, and though the number seems small, and could doubtless be considerably enlarged during a second season, from present experience and observation upon the habits of the young, and in view of the enfeebled condition in which they ordinarily leave the McDonald jar, the claim is unhesitatingly made that 4,000 lobsterlings have the replenishing value of many million fry. The combined previous efforts in rearing at Woods Hole had resulted in raising not more than 500 lobsterlings. Compared with this, the results of these experiments are magnificent.

TABLE IV.—*Details of lobster-rearing experiments at Woods Hole in 1902.*

Experiment No.	Date of hatching.	Date of beginning of experiment.	Number of fry.	Source of fry.	Age of first IVs.	Experiment closed.	Number of IVs.	Percentage.	Food.	Remarks.
1	May 16–19	May 19	3,000	Woods Hole hatchery	25 days	(?)	11	0.36	Lobster liver and clam	Occasionally stirred. On May 26 3,000 in bag. First II on ninth day. Diatoms abundant. Retained in pool until June 4.
2	May 23–27		(?)	do	(?)	June 14	38	(?)	do	Miscellaneous lot. Kept in bags during construction of raft. Diatoms very abundant.
3	June 4	June 6	2,500	do	(?)	July 1	39	(?)	do	
4	June 5–6	do	2,500	Hatched in bag	(?)	(?)	0	(?)	Lobster liver	On June 16, 341 IIs, badly infested with diatoms.
5	June 3	do	(?)	Woods Hole hatchery	17 days	June 23	118	(?)	Clam, menhaden	
6	June 4	do	*a* 14,000	do	(?)	(?)	125	(?)	Clam	
7	June 5	do	(?)	do	(?)	June 24	46	(?)	do	Fed irregularly and scantily.
8	June 6	June 7	*a* 148,000	do	17 days	June 23	47	(?)	Clam and lobster liver	Poorly fed. Many diatoms.
9	June 7	do	(?)	do	(?)	June 25	83	(?)	Lobster liver	On June 25, about 200 IIIs put in with miscellaneous lot.
10	do	June 8	1,000	Rearing bags	(?)	(?)	0	(?)	Clam and lobster liver	Poorly fed.
11	June 8–9	June 10	2,500	do	14 days	June 26	302	12.08	Clam and menhaden	Light excluded. Well fed.
12	June 9–10	do	2,500	Woods Hole hatchery	12 days	June 28	200	8.00	Lobster liver, clam, menhaden.	Do.
13	do	do	*a* 10,000	do	do	June 29	725	(?)	Clam, menhaden	Do.
14	do	do	*a* 2,500	do	12–14 d'ys	June 28	525	21.00	do	Do.
15	do	do	2,500	do	do	June 27	306	12.24	do	Do.
16	June 10	June 11	(?)	do	14 days	July 1	60	(?)	do	
17	do	do	*a* 2,500	Rearing bags	(?)	June 24	144	(?)	do	Fry badly infested with diatoms at beginning of experiment.
18	do	do	*a* 2,500	do	(?)	June 28	35	(?)	do	
19	June 11	June 12	(?)	Woods Hole hatchery	(?)	June 25	0	(?)	Clam	A bad lot. Many diatoms. Poorly fed.
20	June 12	June 13	*a* 2,500	do	16 days	June 30	82	(?)	Clam, menhaden	
21	do	do	(?)	do	12 days	July 2	334	(?)	Clam	Many lost during storm of June 26.
22	(?)	(?)	(?)	(?)	(?)	June 21	65	(?)	(?)	Many lost during storm of June 26.
23	June 12–14	June 15	*a* 5,000	Rearing bags	10 days	June 30	136	(?)	Clam, menhaden	
24	June 12–15	June 16	(?)	do	do	June 25	75	(?)	Menhaden, clam	
25	(?)	do	(?)	do	10–12 d'ys	June 28	76	(?)	Menhaden	
26	June 17	June 18	(?)	Woods Hole Hatchery	(?)	(?)	(?)	(?)	(?)	Failure through storm of June 26.
27	do	do	(?)	(?)	10 days	July 3	141	(?)	Menhaden	Many lost in storm of June 26.
28	June 16–20	June 20	(?)	Rearing bags	(?)	July 1	6	(?)	do	Do.
29	do	do	2,500	do	12 days	July 4	2	(?)	do	Well fed. Carefully handled.
30	July 12–19	do	*a* 2,500	do	(?)	(?)	(?)	(?)	(?)	A killifish entered the bag and ate the fry.
31	June 20	June 21	*a* 300,000	Woods Hole Hatchery	(?)	(?)	(?)	(?)	(?)	Light excluded. Many reached third stage and then died. Very few diatoms.

a Estimated.

TABLE IV.—*Details of lobster-rearing experiments at Woods Hole in 1902*—Continued.

Experiment No.	Date of hatching.	Date of beginning of experiment.	Number of fry.	Source of fry.	Age of first IVs.	Experiment closed.	Number of IVs.	Percentage.	Food.	Remarks.
32	(?)	June 22	(?)	(?)	(?)	June 29	1	(?)	Menhaden	Diatoms abundant. Fry well fed.
33	(?)	(?)	a 3,500	Rearing bags	(?)	(?)	0		do	Failure through storm of June 26.
34	June 20	June 21	a 8,000	do	(?)	July 4	5	(?)	do	Well fed.
35	(?)	(?)	a 3,000	do	(?)	June 30	21	(?)	do	This bag used for miscellaneous lot.
36	June 22	June 23	3,000	do			1	(?)	do	Failure through storm of June 26.
37	June 21–23	June 24	a 7,500	do	(?)	(?)	0	(?)	do	A very few became IIs. Failure through storm of June 26.
38	(?)	(?)	3,000	do			0	(?)	do	Fry were in fine condition. Well fed, but none became IIs.
39	June 25–26	June 27	5,000	do			0	(?)	do	A few alive July 4, mostly IIs, with "mold" spots.
40	do	June 26	2,500	do	(?)	(?)	0	(?)	do	Well fed. No diatoms. Some reached third stage. All died.
41	June 25	June 27	3,000	Woods Hole Hatchery.	(?)	July 8	0	(?)	do	

a Estimated.

From Table IV it will be seen that the results of the experiments varied greatly during the season. First was a period of partial failure, followed about the middle of the season by one of success, while practically all the experiments from June 25 to the close were total failures. It should not be forgotten, however, that in the early experiments at Woods Hole it was unusual to rear more than 1 per cent of a given number of lobster fry to the fourth stage, no matter what kind of inclosure was used or where the experiment was located. In the experiments of 1902, 10, 12, and even 20 per cent of the original number of fry were successfully carried to the lobsterling stage, and these figures are based on actually counted fry, not on estimates.

One cause attending at least the early unsatisfactory results of these experiments was the lack of sufficient food. Great difficulty was experienced in finding a food which the fry would eat and which could be obtained in sufficient quantities to make it practicable. Until the solution of this problem (which is discussed fully elsewhere), the young lobsters were poorly nourished, growth was retarded, parasites flourished; and these conditions were aggravated by moving the plant from place to place. For two or three weeks after the time the food supply became plentiful, the fry in all the experiments grew rapidly and were strong and healthy. In one week more than 2,000 lobsterlings were taken from six bags, one bag alone yielding 725.

The experiments of the latter part of the season, however, were most disappointing. Awnings had been stretched over the bags, and it was found that by excluding the direct sunlight the diatoms were greatly reduced in numbers, but even the disappearance of this enemy apparently had no effect in decreasing the mortality. The development of the fry was different from that heretofore observed. They grew well, and reached the third stage in an apparently strong and healthy condition; they were free of diatoms, were vigorous and active, and fed well; but within a day or two all had died, and the cause of this mortality could not be determined. It was noticed that many of the dead lobsters, and occasionally living ones, had white spots on their bodies. Professor Gorham, who was studying the diatoms, examined many of these spots and found them to be colonies of a mold which had ramified through and through the tissues. Whether this was the primary cause of death Professor Gorham was unable to determine. After its appearance, however, it was almost impossible to raise a single lobsterling. Frequent changing of the bags, exclusion or presence of direct sunlight, or changes in quantity and kind of food made no apparent difference.

That bag experiments like those of 1901 would not have been more successful in 1902, was proved by experiment before the completion of the rearing plant. Fry were placed in one of the cylindrical bags and occasionally stirred. They were regularly fed and had excellent

care for the first two weeks, but in spite of careful attention they did no better than in former years. Although the number received from the hatchery was estimated at 30,000, at the end of the first week only 3,000 were alive. Diatoms infested them, they became inactive, and metamorphosis was retarded. None reached the second stage until the ninth day. Even after the plant was completed, and with the water constantly stirred, only the most vigorous rallied, and but 11 reached the fourth stage after more than 25 days. Thus it would seem that the physical and biological conditions were not more favorable than in other years. The temperature and density of the water were at an average, the plankton was not especially rich, and the natural enemies were present in great abundance. In the past five years diatoms had never been seen so abundant or their growth so rapid.

EXPERIMENTS IN HATCHING EGGS.

Several experiments were made to test the efficiency of the bags as a hatching device, and also for comparison with fry from the hatcheries. According to the hatchery records, about 5,000,000 eggs from the Woods Hole Station and 2,000,000 from Gloucester were turned over to us for this purpose. Although there was no method of determining what percentage hatched, large numbers of fry from these eggs were used in the rearing experiments. The eggs collected from southern New England waters seemed to hatch more quickly and better than those received from Gloucester, and the fry were more hardy. This can be accounted for in part by the fact that Woods Hole and Noank eggs are further developed when collected than Gloucester eggs. Very few of the Gloucester fry became lobsterlings, but as those eggs did not begin to hatch until about the time that all the experiments seemed to prove futile, the results are not especially significant. A comparison of the habits, rate of growth, and vitality of fry from the hatchery and those hatched in the bags did not show any appreciable differences.

The most serious objection to the apparatus as a hatchery is that the diatoms multiply very rapidly, completely coating the unhatched eggs and possibly killing them. This may not prove serious. By excluding direct sunlight the diatoms may be eliminated.

SUMMARY OF RESULTS AND CONCLUSIONS FROM THE WORK FOR 1902.

1. The physical and biological conditions of the water at Woods Hole, at least during the years 1898, 1899, 1900, 1901, and 1902, were extremely unfavorable for the growth of lobster fry. Future experiments in lobster culture should be tried in other localities.

2. The value of a gentle agitation of the water, such as is obtained with this stirring device, was again demonstrated and under most

adverse circumstances. Formerly, no matter what device was used, less than 1 per cent of the fry could be reared to the lobsterling stage. With this apparatus, in an environment so unfavorable for the work as exists at Woods Hole, it is possible to rear 10 or 12 per cent.

3. At Woods Hole eggs hatch very satisfactorily in the bags, and probably as successfully as in the McDonald hatching jars. The fry are strong and active and grow well.

4. Although the diatoms multiply with great rapidity in the bags at Woods Hole, and therefore endanger successful lobster culture, it is probable that exclusion of direct sunlight will prevent their growth.

5. Ground menhaden flesh was found to be a practical food for the young lobsters.

DISCUSSION OF CERTAIN PHASES OF THE LOBSTER PROBLEM.

FOOD OF LARVÆ.

The young lobster comes into the world with a ravenous appetite which is rarely satisfied during the larval period. In spite of this, however, he is something of an epicure. The kinds of food which appeal to him are very few, and on this account the food supply has frequently been a serious question in the course of these investigations. The natural food consists chiefly of the minute organisms—copepods, fish eggs, very young fish, etc.—so abundant near the surface of the ocean, especially in sheltered bays and inlets. All our efforts to nourish the fry in confinement with this food, however, have been unsuccessful, because of lack of constancy in the supply. It is necessary to provide suitable artificial food.

In the experiments of 1898 and 1899 Doctor Bumpus gave much attention to the question of nourishment. Finely chopped fish, such as tautog, cunner, flounder, etc., settled to the bottom, and even when floating was not relished by the fry. Shredded codfish, as purchased at the stores, was more buoyant, but was refused by the lobsters. Flesh and eggs of spider crabs and other crustaceans were little better. The one food which the fry seemed to prefer above all others was the so-called lobster liver or digestive gland of the adult. This gland is composed of numerous small tubules which can be easily chopped into fine particles, and the oil contained keeps the bit of food in suspension for some time. The young lobsters, especially in the first stage, eat this food with great avidity, and a single liver is sufficient to feed many thousand. Lobster liver was used quite extensively as food in some of the early experiments, but it could not be used on a large scale, because it would necessitate the destruction of many lobsters nearly mature.

A more practical food was found in the investigations at Wickford during 1900. Here the fry were fed almost entirely upon the soft

parts of the common clam (*Mya arenaria*), on which they thrived, and as the clam is comparatively abundant in Narragansett Bay, this was the staple food for the experiments at Wickford in both 1900 and 1901. Clams were so scarce in the vicinity of Woods Hole, however, and the difficulty of procuring them from other localities was so great, that an economical substitute was sought. The digestive glands of starfish, soft parts of sea-urchins, the common mussels, and several kinds of fish were tried, but all were refused by the fry. At last was discovered a food which attracted them—the oily flesh of the menhaden—and as these fish were caught in the traps in great numbers in 1902, the food supply was practically unlimited for the rest of the season. The flesh of the menhaden is so saturated with oil that it does not sink quickly. The fish were run through an ordinary meat grinder, still further triturated by a vigorous stirring, and then poured into the bags. This was the staple food throughout the season.

The amount of food is an important item, and should receive careful attention. As stated above, it is necessary to put in the bag more food than can actually be eaten. In the earlier experiments this excess sank to the bottom of the inclosure, quickly decomposed, and fouled the water. The introduction of the stirring device, however, corrected this, and greatly facilitated the feeding of the fry. The current of water lifted the food, as well as the lobsters, from the bottom, and kept them in constant circulation.

During 1902 the fry were fed twice a day (morning and night), a small teacupful of the shredded menhaden being given to each bag, i. e., to about 5,000 fry. As the fry develop they need proportionally more food. There is little danger of overfeeding.

ENEMIES OF THE YOUNG.

It would seem at first glance that the hatching and releasing annually of so many millions of lobster fry must accomplish a great deal toward restocking our waters. No doubt such would be the case if it were not for the many dangers to which the young lobster is subjected, particularly during its larval existence.

The most destructive natural enemies are the small fish, such as cunners, minnows, tautog, etc., which are so numerous along our shores. The light-colored newly hatched larva is a tempting morsel to these fishes, and they doubtless are responsible for the immediate destruction of thousands of fry liberated by the hatcheries. To be convinced of this it is only necessary to observe when a few thousand are released at Woods Hole, for instance. During 1902, frequently 30 to 50 minnows and cunners were counted around a single bag that was being emptied, and the fish were quick to pick up the living fry before touching the dead. In one instance, a single mummichog

entered one of the bags through a hole, and devoured 2,500 fry in a single night.

In addition to the destruction by living enemies the young lobster is also likely to be stranded on the shore by the wind and receding tide.

In confinement, although the fry are protected more or less completely from natural enemies, others equally destructive are encountered and have proved serious obstacles in successful lobster culture, but the experiments encourage the belief that in due time all these difficulties will be removed.

RATE OF GROWTH.

The growth oi the lobster, especially during the larval period, is dependent on two factors, namely, temperature of the water and food supply. Other things being equal, the colder the water the slower the development, and vice versa. This is shown by a comparison of the experiments at the various stations, and also of experiments at the beginning and near the close of the season. For example, at Orrs Island in 1900, when the temperature of the water averaged 60°, it took 25 to 26 days for the fry to reach the lobsterling stage. At Wickford at the same time, with the water at 72°, the fry were only 10 to 12 days in passing through the same metamorphoses. In the one experiment at Annisquam, where the water temperature reached 76 F., the lobsterling stage was reached in 10 days. In the same locality development is slower at the beginning of the season than toward the close. At Woods Hole in the early part of the season, 20 to 25 days were required for the fry to pass through the larval stages, while later 12 to 14 days were sufficient. The same holds true at Wickford, although not so noticeably, since the difference in temperature is not so great. Sixteen days' time was necessary for the fry to become lobsterlings in the first experiment in 1900. Later in the season only 9 or 10 days were needed.

The amount of food the lobster receives is also of importance. Fry which are poorly nourished, if they live for any considerable length of time, will remain in the first stage for as much as 3 or 4 weeks.

To obtain an environment which will encourage a rapid growth is the all-important factor in rearing the fry. The shorter the critical period the greater the chance of surviving it.

POSSIBILITY OF ECONOMIC LOBSTER CULTURE.

The results of these investigations lead to the belief that it is not only feasible to retain the lobsterlings in inclosures until they reach a marketable size, but that such an undertaking might be made a profitable industry. The special commission confined its attention chiefly

to the observation of the larval lobsters and gave only incidental attention to later stages, but Dr. A. D. Mead has made some interesting and suggestive observations on the rate of growth from the lobsterling stage onward, and has valuable data bearing upon comparative mortality. He has retained the young for more than two years, and by direct observation has ascertained many facts of interest. The length of the lobster is not a criterion of age. Although at the end of the first year the average length of the young was $2\frac{1}{8}$ inches, he shows that six months later, while some have grown but little, others are fully 5 inches in length. The average rate of growth, however, is so slow that at least three years, and possibly five, must be allowed for the animal to reach a marketable size. Doctor Mead's experiments prove that it is possible to retain the young for an indefinite period, and that the mortality after the lobsterling stage is reached is very small.

A more conclusive demonstration of the possibility of rearing lobsters for market is perhaps required by the lobster men before they can be persuaded to invest in the enterprise, but that such a scheme can ultimately be made financially profitable is convincingly shown. A simple method would be for the government to cooperate with some lobstermen who control a suitable pound, preferably on the Maine coast, and release there a large number of lobsterlings. It would not be possible to judge of the results for three or four years, but in this way the practical value of artificial rearing could be determined.

Thus far the apparatus used for stirring the water has been crude, and obviously several changes should be made before constructing a permanent plant. Larger bags of more durable material should be used for rearing purposes, though the small bags are good for hatching the eggs, and the annoying and unsatisfactory system of belts for transmitting power should be replaced by a series of gears and worms.

III. THE CAUSES OF DEATH IN ARTIFICIALLY-REARED LOBSTER FRY.

By Frederic P. Gorham,
Associate Professor of Biology, Brown University.

Attempts to rear lobster fry through the first three stages of development under artificial conditions have been attended by many difficulties. Although protected from most of their enemies when kept in confinement, the fry are still subject to attacks of various kinds, and the elimination of these destructive agents must be accomplished before complete success in lobster culture can be attained. Cannibalism was one of the most conspicuous causes of loss in the early experiments, and an abundant growth of diatoms, other algæ, and protozoa, covering the bodies and appendages and interfering with movement and feeding, has destroyed large numbers throughout the progress of the work. A fatal fungus which attacks them has also been a factor difficult to contend with.

During the summer of 1902, at the request of Dr. Hugh M. Smith, then chief of the division of scientific inquiry of the U. S. Fish Commission, I undertook the study of these causes of death in lobster fry, with a view to suggesting remedial measures. Observations were begun as soon as the experimental hatching and rearing plant at Woods Hole was installed. This apparatus was operated under the direction of the special commission for the investigation of the lobster and clam, and is described in detail elsewhere in this report.

CANNIBALISM.

The first fry were placed in the bags May 19, 1902, but the fans were not set in motion until June 3. Cannibalism was especially marked when the fry were in crowded quarters or were allowed to collect in corners. It was evident that they must be kept in a receptacle large enough to allow each individual considerable space to himself; otherwise, if they did not devour each other, they suffocated and became foul. Moreover, they must be supplied with an attractive food with such frequency that they were not tempted to feed upon each other.

The first two of these conditions, plenty of room and continual motion, are well met by the rearing apparatus used by the special commission. The third—that of food supply—requires further attention.

On the securing of a proper food supply depends not only the prevention of cannibalism, but also, as we shall see later, what is of far more importance—the length of time required to pass through the early stages and the escape from the growth of diatoms.

In the experiments at Woods Hole the fry were fed for the most part finely chopped lobster liver, clams, and menhaden. None of these proved an ideal food; perhaps that of most value was the clams. Further experiments to discover a suitable food for the fry are greatly to be desired, as on this depends to a large extent the practicability of rearing the fry at all successfully. A further discussion of this important question will be found under a later section of this paper.

DIATOMS.

It was the abundant growth of diatoms on the surface of the body and on the appendages that first led to a consideration of the causes of death of the fry. It was supposed that the growth was a parasitic fungus, but microscopic examination soon showed that it was merely an external growth of a few protozoa and algæ, and very many diatoms of a few well-defined species. These did not at all endanger the life of the lobster, except in so far as they were a mechanical obstruction to his movements. They did not penetrate his chitinous shell and were all thrown off at each molt.

CORRELATION OF THE LIFE HISTORY OF THE FRY AND THE PRESENCE OF DIATOMS.

Absence of diatoms on adult lobsters and on eggs when attached to the female.—The lobsters and eggs examined came from the immediate vicinity of Woods Hole, from Gloucester, Mass., Block Island and Narragansett Pier, R. I., and from Noank, Conn., and no diatoms were found on the adults or on the eggs when attached to the swimmerets of the female. On the stalks by which the eggs are attached to the appendages of the female there are frequently colonies of a vorticella (*Zoothamnium elegans* D'Udekem), but these are seldom found on the eggs and never on the fry, and so have no bearing on the problem under consideration.

Diatoms on the eggs and fry in the hatching-jars.—When the eggs are placed in the McDonald hatching-jars the diatoms make their appearance within twenty-four hours. The species that first appears, in fact the only species that appears on the eggs while in the jars, is *Licmophora tincta*, the one destined to be the most abundant throughout the life of the fry (pl. IV, fig. 1).

In cases where the fry hatch within twenty-four hours after the eggs are placed in the jars, some of them, in a few hours after emerging from the eggshell, have a considerable number (14–25) of diatoms

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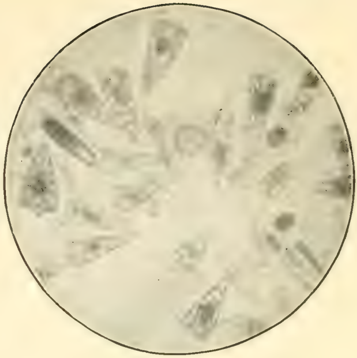

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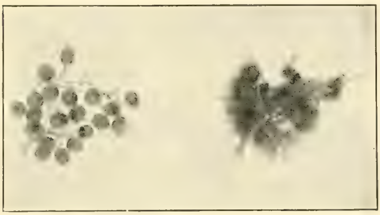

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on their appendages. Others remain perfectly clean. In the hatching-jars the growth of diatoms never becomes abundant either on the eggs, egg-stalks, or fry.

Diatoms on the fry in the rearing apparatus.—As soon as the eggs or fry are placed in the bags of the rearing apparatus, the growth of diatoms is greatly accelerated, and eggs, egg-stalks, and fry are soon covered with them (pl. IV, figs. 3, 6, and 7). The fry become brownish and shaggy to the naked eye, are impeded in their movements and in their feeding, and soon perish unless the act of molting intervenes to rid them of their unpleasant burden.

As already stated, in the hatching jars but one species of diatom is present (*Licmophora tincta*). Upon removal to the rearing bags the number of species increases, and although *Licmophora tincta* is always the most abundant at Woods Hole, other species also are present in large numbers. A list of the species and their relative abundance will be found in a later section.

Diatoms on the different stages of the fry.—The eggs and fry of the first, second, and third stages become badly covered and in many cases killed by the diatoms. When an individual survives and molts to the fourth stage he is less liable to infection. He is now a more active swimmer. He swims not merely to keep afloat, but to go swiftly from place to place, to retreat from danger, or to capture his food. His shell is harder, his limbs and appendages are larger, less feathery, less adapted for the attachment of the diatoms. His manner of life is changed. He now seeks the bottom and crawls about and hides under stones, shells, and seaweed, or even burrows in the sand—a manner of life that enables him to free himself to a large extent from any external growth. But even in this fourth stage certain individuals become covered with diatoms, particularly when they do not have access to a sandy bottom. Individuals of the fourth stage have been observed with a growth of algæ one-half inch long, and in one case an amphipod tube, with its living occupant, was closely attached to the carapace (pl. IV, fig. 5). In this stage, however, diatoms are not so troublesome and probably are never the cause of death, particularly if the fry are transferred to cars with a sandy or gravelly bottom.

DIATOMS AND THE PROCESS OF MOLTING.

As is well known, the process of molting usually takes but a few moments. Not infrequently, however, something goes wrong, the fry becomes entangled in the old shell, the struggle is quite prolonged, and often the lobster dies in the process. The method of molting is the same in all stages of the lobster; the old skin splits across the back between the thorax and the abdomen and the body is worked out from this opening, leaving the old shell with all the appendages intact. If the old shell is covered with diatoms, some of these are

dislodged in the process of extracting the appendages, particularly if the struggle is prolonged, and become attached to the bristles or hairs of the clean appendages. Frequently the number thus attached is large.

RATE OF GROWTH OF THE DIATOMS ON THE FRY.

As soon as a lodgment is obtained upon the lobster the diatoms begin their active growth and soon spread over the whole body. Even a few hours after molting the fry may be badly infested and within two days are so covered with diatoms that they appear shaggy to the naked eye. Fry that molt become covered again within the same length of time. Figures 3 and 4 of plate V show the amount of growth that may take place in 48 hours.

SOURCE OF THE DIATOMS—THEIR NATURAL HABITAT.

From the fact that the diatoms are not present on the eggs while still attached to the female and that they appear immediately in the hatching jars, we are led to suppose that they are present in the water when pumped through the pipes to the hatchery, and that perhaps they grow on the inside of the pipes or hatching jars.

Diatoms in the water pumped to the hatchery.—A quantity of water as it flowed from the supply pipe leading to the hatching jars was filtered and an examination made of the material collected by the filter. The diatom *Licmophora tincta* was present in considerable numbers and with it were the following species, though much less abundant: *Tabellaria* (*Striatella*) *unipunctata*, *Licmophora flabellata*, *Navicula*, (two species), *Pleurosigma* sp. There were present, also, some algal filaments, Vorticella, and fragments of copepods, isopods, and amphipods (*Caprella geometrica*).

The spores of these diatoms are so small that they can not be detected by direct microscopic examination, and the sessile varieties of diatoms, those present on the lobsters, do not grow in ordinary water cultures. It was therefore difficult to demonstrate the presence of spores in the water, but the fact that they are given off in large numbers during certain stages of the growth of diatoms makes their presence highly probable.

On the inside of the hatching jars and on the glass tubes that carry water to the bottoms of the jars, there is almost always a growth of algæ, and on the filaments of the algæ there is usually a growth of diatoms. As far as observed these diatoms were all of one species, *Diatoma hyalinum*. *Licmophora tincta* was never found growing there.

Diatoms in water outside of hatchery.—During September, 1902, a series of observations was made to determine the presence of diatoms in the water outside of the hatchery. In the tow collected on several

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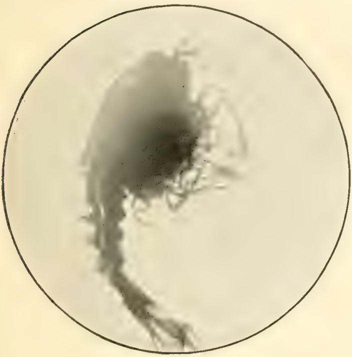

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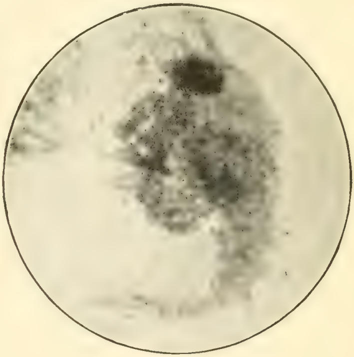

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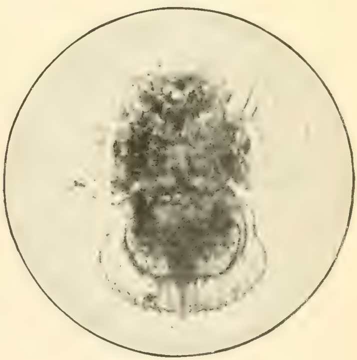

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days, at different times during the month, the following species were found, being named in the order of their abundance:

Chætoceros sp.
Rhabdonema adriaticum Kützing.
Tabellaria (Striatella) unipunctata Agardh.
Navicula sp.
Rhabdonema arcuatum (Lyngby) Kützing.
Licmophora tincta Grunow.
Pleurosigma sp.
Rhizosolenia gracilis H. L. Smith.
Rhizosolenia setigera Brightwell.
Grammatophora subtillissima Bailey.
Diatoma hyalinum Kützing.
Achnanthes longipes Agardh.

It thus appears that the water is filled with living diatoms of both the free-swimming and the sessile varieties, the latter ready to become attached whenever opportunity offers.

DIATOMS ON LOBSTER FRY IN THEIR NATURAL HABITAT AND ON OTHER CRUSTACEA.

The next question was, Do the diatoms become attached to lobster fry when the latter are unconfined—that is, under natural conditions? Only a few lobster fry could be obtained for examination. One taken in the tow near the Fish Commission wharf early in June did not show any diatoms. One of the third stage and two of the fourth or fifth stage, taken at the surface at 11 p. m., 40 miles south of No Mans Land, on July 30, 1902, showed no diatoms. Other crustacea have occasionally been observed to be covered with them. A copepod, probably *Corynura bumpusii*, covered with *Licomophora tincta*, was taken off the Fish Commission wharf by Mr. Vinal N. Edwards on June 24, 1902 (plate V, figure 5). On September 10, 1902, a young *Limulus polyphemus* was taken covered with another diatom, *Rhabdonema adriaticum* (pl. V, fig. 1). A large number of copepods, zoeæ, young squilla, etc., taken in the tow during September, were examined, but with the above exceptions no diatoms were found on crustacea under natural conditions.

Other crustacea besides lobsters, however, when kept in confinement are subject to diatom infection. Dr. M. T. Thompson, during the summer of 1900, found that certain experiments with larval hermit crabs (*Gleucothoe*) had to be abandoned because of the abundant growth of diatoms on the young crabs.

If any conclusion can be drawn from these few observations it is that although the water is filled with diatoms ready to become attached when opportunity offers, they do not ordinarily attack living lobster fry or other crustacea, unless some artificial condition, such as confinement or weakened vitality, is introduced.

DIATOMS ON OTHER SUBMERGED OBJECTS.

Any submerged object is capable of and usually does support a growth of diatoms after it has been in the water a short time. The spiles of the Fish Commission wharf show numerous species, among them *Licmophora tincta*, the one so abundant on the lobsters. The eel grass in all localities is covered with them. Collections from the eel grass show the following species, named approximately in the order of abundance:

August 5, 1902.
- Licmophora flabellata (Carmichael) Agardh.
- Licmophora tincta Grunow.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Rhabdonema adriaticum Kützing.

August 30, 1902.
- Pleurosigma sp.
- Cocconeis scutellum Ehrenberg.
- Melosira sp.
- Nitzschia longissima (Brébisson) Ralfs.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Rhabdonema adriaticum Kützing.

September 10, 1902.
- Licmophora flabellata (Carmichael) Agardh.
- Rhabdonema adriaticum Kützing.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Nitzschia longissima (Brébisson) Ralfs.
- Synedra affinis Kützing.
- Pleurosigma sp.
- Amphora sp.
- Podocystis sp.

The nets of the fish traps, soon after being set, bear a great abundance of individuals and species, and the bags of the lobster-rearing apparatus are particularly well adapted for the attachment and growth of many species. The water set in motion by the fans is continually passing through the scrim of which the bags are composed, and the diatoms are filtered out. They become entangled in the fibrous material, and begin to grow rapidly. It is this growth that is the principal cause of the rapid fouling of the bags. At least once in every two or three days it was necessary to replace the bags in order to keep up the circulation of the water. The following species were found growing on the bags between May 29, 1902, and July 1, 1902:

- Nitzschia longissima (Brébisson) Ralfs.
- Licmophora tincta Grunow.
- Chaetoceros sp.
- Grammatophora marina (Lyngby) Kützing.
- Licmophora flabellata (Carmichael) Agardh.
- Rhabdonema arcuatum Kützing.
- Pleurosigma sp.
- Pleurosigma fascicola W. Smith.

Synedra gallioni Ehrenberg.
Synedra affinis Kützing.
Tabellaria (Striatella) unipunctata Agardh.
Navicula sp.
Cocconeis scutellum Ehrenberg.
Melosira sp.
Melosira nummuloides Agardh.
Cocconeis sp.

It seems as if in these bags we had an ideal method of growing diatoms in large numbers under the most favorable conditions for distributing them to the fry. The circulation of water is continually throwing the fry against the sides of the bags, and if these bags are foul with a growth of diatoms, the fry will become foul almost as soon as they are placed in the bags.

PRESENCE OF DIATOMS AT OTHER LOCALITIES.

At Woods Hole, as we have already seen, the species of diatoms that trouble the lobster fry are distributed quite generally in the water and on all submerged objects. It was desirable to determine whether the same conditions exist at other places along the coast, and examinations were made with this in view.

Conditions at Gloucester, Mass.—In the hatching jars at Gloucester, on the inside of the glass and on the tubes, June 21, 1902, there were found a very few *Licmophora tincta*, along with several other species (*Coscinodiscus* sp., *Cocconeis* sp., *Navicula* sp., *Rhabdonema arcuatum*). In no case were diatoms as abundant as in the same places in the Woods Hole jars, however. In fact, considerable search was required to find any, and none of the fry taken from the hatching jars at Gloucester showed a single diatom. They were perfectly clean, in decided contrast to the condition of the fry in the jars at Woods Hole.

Conditions at Wickford, R. I.—Experiments in lobster culture have been carried on for the past three summers (1900, 1901, 1902) at Wickford, R. I., at the floating laboratory and hatchery of the Rhode Island Fish Commission. The first year the fry were confined in large square bags made of scrim, fastened to a float and weighted at the lower corners. A few unsuccessful experiments were made with cars. One experiment was tried in which the water in the bags was continually stirred with an oar for six days. Doctor Mead states in the Report of the Rhode Island Fish Commission for 1901 (page 71) that "a larger proportion of fry was obtained from this experiment than from any other ever tried at Wickford, Woods Hole, or elsewhere, and also that one of the most encouraging results of the experiment was the clean and healthy appearance of the fry at all stages. The continual stirring prevented the accumulation of the parasites found on the bodies of nearly all specimens in the other lots." This seems to indi-

cate that at times during this year some of the fry were troubled with a growth of diatoms.

During the next year, 1901, an apparatus similar to that already described in this paper was installed at Wickford with the cooperation of the U. S. Fish Commission. As far as can be learned very little trouble was experienced from the growth of diatoms during the year. The only statement in regard to diatoms in the report of the Rhode Island fish commission for 1902 is that "at certain periods during the summer a great quantity of diatoms and other small organisms, both plant and animal, are caught in the meshes of the scrim bags and there accumulate to such an extent that the circulation of the water is often interfered with." Nothing is said about their presence on the fry, and Doctor Mead states that they were not sufficiently abundant to be noticeable.

During 1902 a new style of apparatus was installed at Wickford, consisting of large square canvas bags, 12 by 12 by 5 feet, with small windows of copper netting, as described in the report of the Rhode Island fish commission for 1903. In the bottom of these bags fans revolved as in the other experiments. Fry reared in these bags remained clean until the first of July, while during the same summer at Woods Hole diatoms were abundant on the fry throughout the season. A few fry obtained from Wickford on June 30, 1902, showed a very few *Licmophora tincta* and some *Tabellaria* (*Striatella*) *unipunctata*, *Navicula* sp., *Rhabdonema arcuatum* and *Rhabdonema adriaticum*, but the diatoms were not sufficiently abundant to be noticeable to the naked eye. The fry infected had been hatched at Woods Hole and immediately transferred to Wickford. The first week in July diatoms began to be abundant on some of the fry at Wickford, in all cases the first affected being those hatched at Woods Hole, which, as we have already seen, were quite badly infected before leaving the hatching jars at that place. Fry hatched and reared at Wickford did not begin to show a growth of diatoms until after July 8, 1902. The same species were present on the fry hatched and reared at Wickford as on those hatched and reared at Woods Hole, but the relative abundance of the different species varied, as is shown by the following table, which gives the names of the eight most abundant species found on the fry of the two localities.

On fry hatched and reared at Woods Hole:

- Licmophora tincta Grunow.
- Diatoma hyalinum Kützing.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Tabellaria (Striatella) unipunctata Agardh.
- Licmophora flabellata (Carmichael) Agardh.
- Synedra gallionii Ehrenberg.
- Synedra affinis Kützing.
- Grammatophora marina (Lyngby) Kützing.

On fry hatched and reared at Wickford:

- Grammatophora marina (Lyngby) Kützing.
- Synedra gallionii Ehrenberg.
- Synedra affinis Kützing.
- Tabellaria (Striatella) unipunctata Agardh.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Rhabdonema adriaticum Kützing.
- Cocconeis scutellum Ehrenberg.
- Licmophora tincta Grunow.

On fry hatched at Woods Hole and reared at Wickford:

- Grammatophora subtillissima Bailey.
- Synedra gallionii Ehrenberg.
- Synedra affinis Kützing.
- Rhabdonema adriaticum Kützing.
- Rhabdonema arcuatum (Lyngby) Kützing.
- Tabellaria (Striatella) unipunctata Agardh.
- Nitzschia longissima (Brébisson) Ralfs.
- Licmophora tincta Grunow.

From a consideration of the conditions at Wickford it seems as if fry reared there were less liable to infection by diatoms than those reared at Woods Hole, even though the same species of diatoms are present at both places. The fry hatched at Woods Hole were the first to show a growth of diatoms when reared at Wickford, and perhaps introduced the troublesome species in large numbers to the rearing bags there. It is noticeable that the most abundant and troublesome species at Woods Hole was the eighth most abundant species on fry hatched and reared at Wickford.

The character of the material of which the rearing bags are made may have something to do with the abundance of diatomaceous growth, not only on the bags, but also on the fry to which the bags so readily distribute it. It is certain that the canvas bags used at Wickford in 1902 did not become foul for a considerable period, while the scrim bags used at Woods Hole had to be changed every few days. This may explain the later appearance of the growth on the fry reared at Wickford as compared with those reared at Woods Hole.

Conditions elsewhere.—Elsewhere than at Woods Hole and Wickford experimental rearing of fry has not been tried except in a very imperfect way. In 1900 some preliminary experiments were tried at Orrs Island, Maine, and Annisquam, Mass. In the former locality diatoms were abundant on the fry; at the latter they were present in less numbers. The higher temperature of the water and the consequent more rapid growth of the fry probably explains the comparative freedom from diatoms at Annisquam. The temperature there was sometimes as high as 76° F., and the lobsterling (fourth) stage was reached in ten days.

SEASONAL DISTRIBUTION.

Hardly enough data have been collected to draw any conclusions in regard to the seasonal distribution of the diatoms affecting the lobster fry. A few facts have been noted, however. During the time that lobster fry were being reared at Woods Hole, from June 1, 1902, until the middle of July, about the same relative abundance of species growing on the fry obtained from first to last. *Licmophora tincta* was always the most plentiful. *Licmophora flabellata* was occasionally present early in the season, but later, about July 5, 1902, it became much more abundant. In some cases this species was practically the only species attached to the carapace, *Licmophora tincta* and the other species being confined to the limbs and abdomen.

That the later appearance of the diatoms on the fry at Wickford had anything to do with their seasonal distribution is doubtful; the temperature of the water may have had some influence, but it seems hardly probable because of their absence the previous season, and also because Wickford temperatures are, as a rule, higher than those at Woods Hole. The explanation already given—the infection of the bags by the fry brought from Woods Hole—seems more reasonable.

SPECIES OF DIATOMS FOUND ON LOBSTER FRY.

Below is a list of all diatoms found on lobster fry hatched and reared at Woods Hole, in the order of their abundance:

Licmophora tincta Grunow.
Diatoma hyalinum (Kützing) Grunow.
Rhabdonema arcuatum (Lyngby) Kützing.
Tabellaria (Striatella) unipunctata Agardh.
Licmophora flabellata (Carmichael) Agardh.
Synedra gallionii Ehrenberg.
Synedra affinis Kützing.
Grammatophora marina (Lyngby) Kützing.
Grammatophora subtillissima Bailey.
Melosira sculpta Kützing.
Cocconeis scutellum Ehrenberg.
Actinoptychus undulatus Ralfs.
Hyalodiscus subtiles Castracane.
Coscinodiscus concavus Ehrenberg.
Navicula lyra Ehrenberg.
Navicula didyma Ehrenberg.
Nitzschia vivax W. Smith.
Nitzschia longissima (Brébisson) Ralfs.
Schizonema americanum Grunow.
Navicula sp.
Rhabdonema adriaticum Kützing.
Campylodiscus sp.
Actinoptychus sp.
Amphora sp.

STRUCTURE AND LIFE HISTORY OF DIATOMS.

The diatoms are a well-defined group of aquatic plants not closely related to any other. Perhaps they should be placed nearer the brown algæ, Phæophyceæ, than any other group, and might be defined as unicellular algæ, characterized by a silicification of the cell wall and by the presence of chlorophyl and a brown pigment, diatomin. Though unicellular, they may be united in chains or filaments, or, by the secretion of a gelatinous material in the form of an inclosing sheath or a supporting stipe, they may form colonies of characteristic shape adhering to plants or other submerged objects.

Cell structure.—Though the diatoms appear in a great variety of forms and sizes, their structure is essentially the same in all. The cell is inclosed in a shell composed of silica, consisting of two symmetrical parts or valves, which are in contact at their margins with an intermediate hoop or girdle. In some forms one valve fits over the other like the cover of a pill box. The girdle may be single or double or complex in structure, with one or more plates inserted between the top of the valve and the girdle. The siliceous shell is usually elaborately and exquisitely sculptured, the extreme delicacy of the details with which the valves are ornamented making the diatoms most beautiful objects under the microscope, and testing its highest powers.

The form of the diatom varies with the habits of the species. Most of the free-swimming forms are oblong, oval, or spindle-shaped; the fixed species are usually of different shape at their free and attached ends; the floating forms have special contrivances for increasing their buoyancy.

The cytoplasm is disposed, peripherally, as a lining to the cell wall; centrally, it may form a bridge across the center of the cell or may take the form of a stellate mass with a series of radiating threads extending out to the peripheral cytoplasm. The nucleus is in the peripheral cytoplasm close to the cell wall, is suspended by the protoplasmic bridge, or is in the center of the stellate mass of cytoplasm.

Chromatophores are always present in the cells. They are yellowish-brown in color and contain besides chlorophyl the peculiar pigment diatomin. The chromatophores vary in number in the different species and take the form of bands, granules, or rounded masses arranged irregularly or in radiating lines. The arrangement of the chromatophores is not constant even in the same individual. An amorphous mass may become divided into numerous granules of equal size and definite outline. There seems to be some definite relation between the arrangement of the chromatophores and the growth and division of the whole frustule. In some species a few round oil globules are also present in the cytoplasm.

Motility.—Many of the free-living diatoms have the power of movement. The mechanism of this motion has been variously explained: (1) As produced by pseudopodia of protoplasm extending through openings in the cell wall; (2) by the presence of cilia extending through the cell wall; (3) by endosmatic currents of water passing in and out of the cell. As the diatoms on the lobster were all fixed species, the matter of motion was not specially investigated in connection with the present question, although frequently in stained specimens apparent cilia were observed extending from all sides of the frustule. This same appearance has been noted in some of the motile forms, and it has been suggested, on what grounds I can not say, that these cilia are probably fungoid growths.

Reproduction.—The ordinary method of multiplication of the diatoms is simple cell division. The nucleus divides first, the chromatophores divide either before or after the division of the protoplasm, and two new cells are formed within the old pair of valves. Each of the new cells forms a new valve on its inner side, so that the new valves lie back to back along the line of division. In cases where the valves are of unequal size, as each old valve becomes the larger valve of the new diatom, it follows that after division the daughter diatoms are smaller than the original. In those species in which the valves do not increase in size this results in a great diminution in the size of the new diatoms, and the original size is again restored by the formation of "auxospores."

The formation of auxospores was at one time supposed to take place merely to compensate for the reduction in the size of the diatoms by repeated cell divisions. They are more properly considered as forms of reproduction. Two kinds must be considered—the asexual and the sexual auxospores. In the former the cell contents separate from the cell wall, increase greatly in size, with or without division and subsequent coalition, surround themselves with a membrane, and finally form a new diatom within, of the maximum size of the species. In the sexual method the cell contents escape from two cells, fuse, a true fertilization takes place, and a new diatom is formed from the resulting cell either at once or after a preliminary division.

The formation of swarm spores in the diatoms has not been observed, although in many species there are indications that some such phenomenon occurs. From the relation of the diatoms to other algæ in which this is a common method of reproduction it seems most probable that it does occur. A few species form resting spores. The protoplasm of the cell becomes condensed into about one-third of its normal volume, and a thick cell wall of definite and peculiar shape is formed about it. In this state the diatoms are extremely resistant and are able to await the return of more favorable conditions, when they reassume the original form of the species.

Licmophora tincta Grunow.—Of all the species found on the lobster fry the most abundant is *Licmophora tincta* Grunow. This form was found on every fry examined, and in most cases constituted over 90 per cent of all the growth present. It is also abundant, as we have already seen, in the water and on submerged objects generally. It seems to be particularly adapted for lodgment and growth on young crustacea of various sorts, however, especially when they are kept in confinement. The species occurs only in salt water, and though the genus was named by C. Agardh as early as 1827 and the species by A. Grunow some time later, yet it has appeared under many synonyms. The species are in many cases doubtfully distinct, and this may account for the fact that the early synonymy is inextricable. Following are some of the names:

Gomphonema tinctum Agardh.
Riphidophora elongata Kützing.
Riphidophora oceanica Kützing.
Riphidophora superba Kützing.
Riphidophora meneghiniana Kützing.
Podosphenia hyalina Kützing.
Podosphenia β Kützing.
Podosphenia racemosa Kützing.

In shape the frustules are more or less cuneiform in front view, convex in side view, inflected at the larger end. They show transverse striæ ranging from 27–28 per 0.01 mm. at the base to 30–31 at the center and 33 or more at the top. A pseudoraphé is easily apparent. The endochrome is arranged in a radiating manner about the nucleus and cytoplasm in the center of the frustule, or may appear as regular oval granules scattered throughout the frustule. The frustules are mounted on a gelatinous stalk, at first represented by a simple knob at the end of the cell, but this later grows out into a stalk which divides dichotomously as the cells divide, and finally forms a much branched stipes of considerable length and complexity. (Pl. IV, fig. 1.)

What were taken to be auxospores were observed in one or two instances (pl. IV, fig. 2), but no evidence of other spore formation, either swarm or resting spores, was seen, nor any evidence of conjugation.

OTHER GROWTHS FOUND ON LOBSTER FRY.

Algæ.—Although diatoms are the first and most abundant organisms that appear on lobster fry, they are by no means the only ones. On both Woods Hole and Wickford fry filaments of a green alga are frequently seen. This occurs principally on the fry of the first, second, or third stage, but individuals of the fourth stage have been observed with very abundant algal growths.

Protozoa.—On many fry are found, more or less abundantly, specimens of the stalked protozoan, *Ephelota coronata* Strethill Wright. This protozoan was observed on fry at Woods Hole on June 17 and July 3, 1902, and was probably more or less abundant throughout the season. At Wickford it was especially abundant early in July (1–8), sometimes as many as 86 individuals being found on one fry.

Crustacea.—One specimen of a tube-dwelling amphipod was observed at Woods Hole on the back of the carapace of a fry in the fourth stage. (Pl. IV, fig. 5.) In no case were the algæ, protozoa, or crustacea so abundant that they caused any serious inconvenience to the fry.

SUGGESTIONS FOR THE PREVENTION OF THE GROWTH OF DIATOMS ON THE FRY.

As will be seen from a consideration of the foregoing facts, the successful rearing of lobster fry depends to a large extent on the discovery of some method of combating or getting rid of the growth of diatoms. The following suggestions are derived from these observations:

Filtering the water in which the fry are kept.—This method of removing diatoms could of course be applied only to the water in the hatching jars; it would be a practical impossibility to filter the water in which the fry are kept in the rearing apparatus. Inasmuch as we have learned that the troublesome species of diatoms are present in the water as it flows into the hatchery, however, and that in many cases the diatoms become well established on the fry before the latter are removed from the jars, it would certainly retard and to a large extent prevent the rapid growth of diatoms during the first molts of the fry if the water supplied to the hatching jars were filtered. No very elaborate filter would be required. It would not be necessary to remove the smallest organisms, such as bacteria, though this would certainly be an advantage for other reasons. Experiment would determine the sort of a filter required. It might be that a settling basin would be all that is necessary for the removal of both diatoms and their spores.

Selection of other localities for the rearing apparatus.—Experimental rearing of the fry has been practiced at but few localities—Orrs Island, Me., Annisquam, Mass., Gloucester, Mass., Woods Hole, Mass., and Wickford, R. I. Diatoms occurred in all these localities, but were somewhat less abundant at Annisquam and Wickford. Whether this was due to a difference in the temperature of the water—the temperature at Annisquam and Wickford was somewhat higher than at the other localities—or to other conditions, can be determined only by experiment. It may be that there are other places along the coast where greater differences of temperature or other local con-

ditions might still further reduce the growth of diatoms; the possibility of finding such a place warrants a series of trials in several localities. It must be borne in mind, however, that Woods Hole fry when they come from the hatchery are infected with the diatoms and that they are liable to introduce these diatoms to any locality where such an experiment is tried. Fry from Gloucester, on the other hand, are apparently free from infection when they come from the hatchery.

Changes in the rearing apparatus.—There is no doubt but that the scrim bags are to a large extent responsible for the rapid growth of diatoms on the fry. As has already been shown, the bags rapidly become foul from a growth of diatoms and other organisms filtered out of the water as it passes through them. The fry are continually coming in contact with the bags, and the diatoms, being easily dislodged, readily become attached to the feathery appendages of the fry. The use of canvas bags with copper netting windows, as tried at Wickford in the experiments of 1902, seems to prevent to a large extent the rapid fouling of the bags and the consequent growth of diatoms on the fry. A more frequent changing of the bags would perhaps bring the same result, but this method is hardly practicable. Perhaps there is some other material of which the bags might be made on which the diatoms would not grow so easily, or there may be some preparation, such as tar or oil, with which the bags might be coated, that would prevent the attachment of the diatoms. It is certain that the cleaner the bags the longer the fry remain free from diatoms. If the fry were received clean from the hatchery, or were hatched directly in the bags and the bags were kept perfectly clean, there would be little trouble from diatoms.

Sunlight and shade.—Diatoms are chlorophyl bearing plants, and consequently require sunlight for their best and most rapid development. Might not their growth be restrained by confining the fry in bags shielded from the direct light of the sun? Several experiments were made to determine this point. On June 22, 1902, an awning was placed about 3 feet above the level of the water over certain bags containing fry in the first stage. The number of diatoms on the fry under the awning steadily decreased, or at most did not develop further than their original condition, and the difference between the control fry in the sunlight and those in the shade was easily apparent to the naked eye. Some of the fry that molted from the first to the second stage were without a trace of diatoms apparent to the naked eye, while those in the sunlight showed a considerable growth. On the other hand, however, the fry themselves seemed to be influenced unfavorably by the absence of sunlight. They had less pigment in their shells and seemed much less active than those in the sunlight.

Further experiments were not tried at Woods Hole, but at Wickford some observations were made bearing on this point. During the summer of 1901 an awning shaded all the bags in which the lobster fry were reared. This awning was about 9 feet above the water, so that while the direct sunlight was excluded there was a considerable amount of diffused light. During this summer there was very little trouble from diatoms. In 1902 the awning was not used and there was a very abundant growth of diatoms. It may be that some other condition had something to do with this result, but it seems very certain that, although the exclusion of the greater part of the light may be injurious to the fry as well as to the diatoms, a cutting off of the direct sunlight, without excessive shading, is an important factor to be considered in all attempts to get rid of the great abundance of diatomaceous growth that ordinarily occurs.

Hastening the development of the fry.—The last and perhaps the most promising remedy that suggests itself is to hasten the development of the fry. A rapid series of molts prevents the excessive growth of the diatoms. If by means of proper care and proper feeding the fry can be so hastened through their early stages that the diatoms have no chance to develop to an injurious extent, the problem is solved in the most advantageous way. This economy of time will be felt not only because of its influence on the growth of diatoms but also in the running of the apparatus and in the attention of those employed to care for the fry.

The principal factors on which depend the rapidity of growth and the freqency of molting are temperature and food. Dr. A. D. Mead, of the Rhode Island fish commission, seems to think that the temperature is the most important factor, as will be seen from the following statement by him in the Report of the Rhode Island Fish Commission for 1901:

> The average period between hatching and reaching the fourth stage for the entire eleven experiments at Wickford was a little over 12 days. In each experiment the average duration of the first three stages varied from 9 to 16 days. In experiments conducted at Woods Hole the time required for these molts was considerably greater; of the first lot, hatched May 23, the fourth stage was reached by a few only on June 12, after an interval of 20 days. Indeed, on the twelfth day (the average time of reaching the fourth stage at Wickford) none had reached even the third stage at Woods Hole. The explanation of the variations in the length of time required for the first three stages probably lies in the differences of temperature of the water—the colder the water the slower the development.
>
> It is not possible to say at present that the variations in the length of the early stages are due entirely to the differences in temperature, and it may be that other factors have more or less influence: but it is extremely probable that temperature is the main factor.

This conclusion seems justified to some extent also by the experiments of the special commission at other points on the coast, as follows:

Locality.	Temperature of water.	Time required for first three stages.
	° F.	*Days.*
Orrs Island	57–63	25–26
Woods Hole	63–65	22–25
Wickford	65	16
Do	72	9
Annisquam	76	10

On the other hand, the question of a proper food supply seems quite as important as the temperature. It is true the temperature affects animals, particularly the invertebrates of the salt water, to a large extent. Their activity in getting about, in finding and capturing their food, and the metabolism of that food depend altogether on the temperature; but unless proper food is supplied them their increased activity is of no avail, growth does not occur, and the temperature consequently has no influence on the rapidity of their development.

The temperature can, of course, be regulated only by changing the location of the rearing apparatus. The food supply can be varied at will. The experiments thus far made with different foods are not very satisfactory, and it seems to me that this question deserves more attention on the part of those engaged in rearing the fry. About all that can be said at present is that they will not eat finely chopped mussels, starfish liver, beef liver, scup, or herring; that they will eat finely chopped clams, periwinkles, blue crabs, lobster liver, and menhaden. Of these, the clams and menhaden have proved the most practicable, though at Woods Hole the former were difficult to obtain and the latter was found so full of oil that the water and bags were quickly fouled by it. Of course the natural food, consisting principally of small copepods, crustacea, diatoms, and algæ, is out of the question, because of the impossibility of securing it in sufficient abundance.

In spite of the fact that the food thus far used has not been particularly favorable, it has been found possible to reduce the critical period, under proper conditions of temperature and feeding, from 25 days to about 9 days. There is no reason why, with better conditions in the rearing apparatus, and better feeding, perhaps in localities better adapted as far as temperature is concerned, it would not be possible to still further hasten these changes. If, however, this shortest period were made the average period for all experiments, the growth of diatoms would not seriously menace the fry.

PATHOGENIC FUNGUS.

On June 30, 1902, it was noticed for the first time that many of the fry in some of the rearing bags were turning white and dying. The entire number in some bags eventually died. Upon investigation it was found that the bodies of the dead fry were filled with the mycelial filaments of a fungus.

This growth was found to begin in most cases in the third or fourth segments of the abdomen, where the first indication of its presence was the opaque, whitish appearance of these segments in contrast to their almost transparent normal condition. It soon spread throughout the body of the fry, destroying all the internal organs, until the chitinous shell was full of closely packed mycelium (pl. VI, fig. 1).

The fungus was isolated in pure culture. It grew on the ordinary bacterial culture media, and was also cultivated on salt water agar and on sterile potato and bean pods. In all cases the aerial growth was pure white. A colony growing on salt water agar is shown in figure 3, plate VI. The growth is a branching septate mycelium (pl. VI, fig. 2), which soon breaks up into a number of short segments resembling large bacilli (pl. VI, fig. 5), and probably representing arthrospores or conidia. In certain filaments the formation of what are apparently endospores was observed (pl. VI, fig. 4).

Some inoculation experiments were made with the fungus, but owing to the lateness of the season when the fungus was isolated young lobster fry were not to be had. Inoculations were made in fish, shrimp, and old lobsters, but were not very successful.

The fungus is to be classified, presumably, among the Oosporeæ, as one of the Hyphomycetaceæ of the fungi imperfecti. Its final identification and complete life history are to be worked out at some future time. Its origin is not known, but is probably traceable to the oily menhaden flesh with which the fry were being fed, thus getting into the intestinal tract. Another season's observations will be necessary to determine the origin, habits, and complete life history of the fungus, and until then no suggestions can be made as to methods of prevention.

CONCLUSIONS.

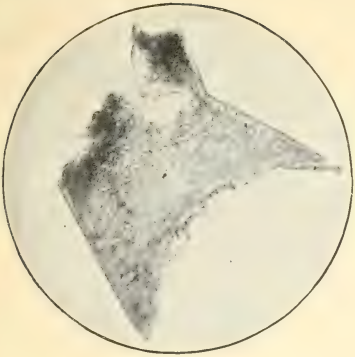
1. The principal causes of death in artificially reared lobster fry are cannibalism, an external diatomaceous growth, and a pathogenic fungus.

2. Cannibalism may be prevented by avoiding overcrowding and by providing some method of keeping the fry continually in motion.

3. The diatomaceous growth may be prevented or to a large extent reduced by—

   (a) Filtration of the water supplied to the hatchery.

   (b) Selection of a place for the location of the rearing apparatus where diatoms are least abundant.



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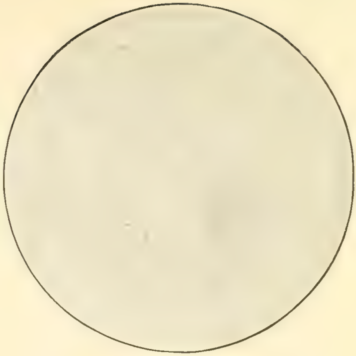

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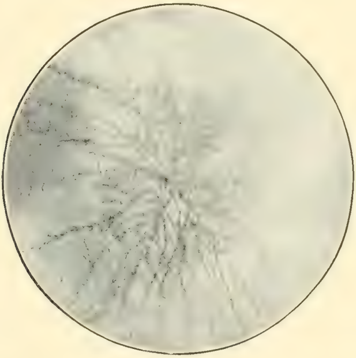

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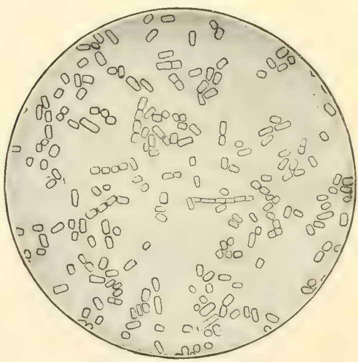

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(c) Keeping the rearing bags free from diatoms by changing the material of which they are composed, by coating them with some substance which will not permit the attachment of diatoms, or by more frequently substituting new ones.

(d) Regulation of the amount of light to which the fry are exposed.

(e) Hastening the development of the fry by locating the rearing apparatus where the most favorable temperature may be secured, and by supplying the most suitable food.

4. The pathogenic fungus, though known to be extremely fatal and disastrous to the successful rearing of fry if once introduced into the bags, has not been studied sufficiently to warrant any suggestions as to methods for its prevention.

EXPLANATION OF PLATES.

PLATE IV.

Figure 1. The diatom *Licmophora tincta* Grunow, growing on the back of a lobster fry. X 150.

Figure 2. The same, showing the cellular structure of the frustule and the formation of auxospores, X 200.

Figure 3. Clean lobster eggs and eggs covered with a growth of diatoms. Natural size.

Figure 4. Clean lobster fry of the fourth stage. Natural size.

Figure 5. Lobster fry of the fourth stage covered with diatoms and a tube-dwelling amphipod, Natural size.

Figure 6. Clean lobster fry of the third stage. Natural size.

Figure 7. Lobster fry of the third stage covered with diatoms. Natural size.

PLATE V.

Figure 1. Claw of lobster fry of the third stage covered with diatoms. X 50.

Figure 2. Claws of lobster fry of the third stage covered with diatoms. X 50.

Figure 3. Clean fry of the first stage. X 10.

Figure 4. Fry of the first stage two days later covered with diatoms. X 10.

Figure 5. Copepod, *Corynura bumpusii* Wheeler, covered with diatom *Licmophora tincta* Grunow. X 30.

Figure 6. Young *Limulus polyphemus* Linnæus covered with diatom *Rhabdonema adriaticum* Kützing. X 15.

PLATE VI.

Figure 1. Posterior segment of lobster fry of third stage filled with fungus mycelium. X 25.

Figure 2. Mycelium of fungus. X 200.

Figure 3. Colony of fungus on salt water agar. X 25.

Figure 4. Mycelium of fungus showing endospores. X 250.

Figure 5. Mycelium of fungus broken into arthrospores or conidia. X 250.

IV. CONDITIONS GOVERNING EXISTENCE AND GROWTH OF THE SOFT CLAM (MYA ARENARIA).

By James L. Kellogg,
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An examination of any extensive clam-flat will reveal the presence of clams only in certain localities. This would be true where digging had not been excessive, or even where there had been no digging. It perhaps would be impossible to-day to find large flats which are not dug, but if it were possible, clams would be found only here and there, large parts of the flats being barren. Certain areas, too, bear clams for a number of years, and then become barren, even when not dug excessively, and this might happen if they were never molested. We may sometimes witness, also, the gradual appearance and establishment of clams on patches of bottom which had previously been unproductive for long periods.

Without taking into account the all-powerful human factor, we may believe with certainty that the clam perpetuates itself only by overcoming many adverse circumstances, or more properly, by being able to take advantage of favorable conditions when they happen to arise. It of course is true of all organisms that they require, for existence, certain very definite and often complicated conditions in their surroundings, and that they will not be found where the peculiar combination of required circumstances and conditions is not present. We search for a certain species of violet not on open unshaded marshes, nor in high sandy woods, but in the rich earth of woods which contains a large amount of moisture in the spring when the plant is in blossom.

In looking out over a great expanse of sand which is exposed at low tide one is impressed with its monotony. There is here no contrast of light and shade. There are no elevations, and nothing to suggest ravines or valleys except the narrow gutters which carry off the last of the retreating tide. It requires a closer scrutiny to reveal any vegetation whatever, though it is present in places, and plays, as will be shown, an important part in determining the existence of the clam. Everything seems to be equally and monotonously exposed, and flat and barren. Yet the conditions are not by any means the same in all parts of the flat. The variations in character of bottom and tide are so great that clams may exist in one spot, the boundaries of which are sharply drawn, and may not live in others.

While we know in a general way some of the conditions that are necessary for the existence of certain animal forms, it is strange that they have not been more closely studied in specific cases among animals which are not domesticated. We have many reasons for the belief that these factors are often excessively complex, and hence difficult to discover. No doubt even a superficial study, however, would reveal in most cases many facts which would be worth knowing concerning the creature's relation to its environment.

There are two reasons for giving here a brief account of some observations upon the conditions controlling and determining the clam's existence. These few observations relating to the environment, though they leave much to be learned, may be of some biological interest, and, in the second place, they seem sufficient to formulate a plan for clam culture, which, in the now depleted condition of our clam shores, is certainly needed. They are not all included under one heading, but are scattered through the following account, and concern both the natural open flats and the isolated localities where the young sometimes collect, in enormous numbers, only to be destroyed. The conditions determining the possibility of mere existence, as well as those which allow the most rapid growth, have been studied more carefully in artificially constructed beds.

CONDITIONS OF NATURAL GROWTH ON BEACHES AND FLATS.

CHARACTER OF THE BOTTOM.

The soil must be somewhat tenacious.—It is impossible for clams to exist where there is much shifting of the bottom. The animal is buried deep, and reaches up to the surface only by its siphons. When foreign bodies, even sand grains in sufficient number, touch the sensory tentacles at the opening of the incurrent siphon, the whole organ is withdrawn for a greater or less distance into the burrow. It is probably true that a few sand grains coming in contact with the ends of the siphons will not cause their retraction, for we usually find more or less sand in the digestive tracts of clams which live on sandy flats. A larger quantity, however, will cause a withdrawal, and into the opening thus left sand may collect and, settling closely, so effectually close it that the siphons can not again be pushed up to the surface. Deprived of the food and oxygen-bearing stream of water, the clam quickly perishes.

Planting experiments will fail unless great care is exercised in selecting a bottom which does not shift. A certain bank on a large flat is recalled, which is said formerly to have yielded many clams. Its surface showed ripple marks, but clams were recently planted on it and at once were smothered. This experience also shows that con-

ditions change, so that tracts once favorable for clams may no longer support them. The nature of some of these changes will be mentioned later.

Clams are sometimes found in beds of almost pure sand, but in such cases the water currents disturb the bottom very little. Even when established in such localities, however, their condition is precarious, for a gale or an unusually strong tide may at any time overwhelm them. Such a destruction has often been noticed. In this connection it may be stated that very slow currents sometimes prevent the existence of clams by depositing fine silt which they hold in suspension; this on settling has the same effect as shifting sand. Of course not all slow currents deposit, for many times they carry little or no sediment. At the heads of estuary-like arms of the sea which receive fresh water streams, one often finds such a deposit of mud, in which clams are not living, although clam food may be present in large quantities.

As in pure sand, so also in nearly pure mud, clams are sometimes present; but here also the action of currents and waves disturbs the bottom very little, and there is no very active deposition of silt.

Cementing substances.—(a) Fine sediments. The surfaces of clam beds are tenacious from several causes. When sand is mixed with fine sediments, its grains are held by this cementing substance. Clay, the finest of sediments, resists the erosive action of water to a considerable degree, and it is often found in more or less abundance on clam flats. Much of the best ground on a clam flat is often a tenacious mixture of sand and fine sediment.

(b) Growth of algæ. Another very important agency in rendering the surface tenacious, and thus preventing the shifting of its particles, is the growth of algæ, which forms a close, thin mat over certain areas, which are sometimes very extensive. The presence of the algæ gives a flaky or cake-like appearance to the bottom. It does not extend deep into the sand, but binds the surface grains closely enough to prevent their movement even by strong currents. This firm dark-green crust has been seen on beds in many localities, but the plants composing it have not been identified. Whether the growth occurs only where currents are swift has not been determined, but certain localities have been noticed to have this covering where the tide rushes with much force. This combination of firm bottom, which prevents erosion, and swift current, bearing abundant food, seems to afford the best conditions for clam growth.

(c) The growth of thatch and eelgrass. The growth of thatch plants or eelgrass may convert a waste of sand into a clam bed. Thatch is found on many beaches between the tide lines, and also covers large parts of clam flats. The plants grow close together. Their blades rise to a height of 2 or 3 feet, and their roots form a feltwork beneath

the surface. As the conditions of the bottom change from year to year the growth gradually spreads from one place to another. In this mass of vegetation clams are often found in numbers, even when the soil is almost pure sand and the currents are swift. The reason that they are able to establish themselves is that the growth of so many plants prevents any shifting of the bottom, and still does not interfere greatly with the food supply.

On account of the long wire-like roots it is very difficult to dig these tracts, and in view of the sadly depleted condition of our beaches and flats the circumstance is a fortunate one, for there is preserved in these beds a supply of breeding individuals which, if proper methods are employed, may reestablish areas rendered barren by excessive digging.

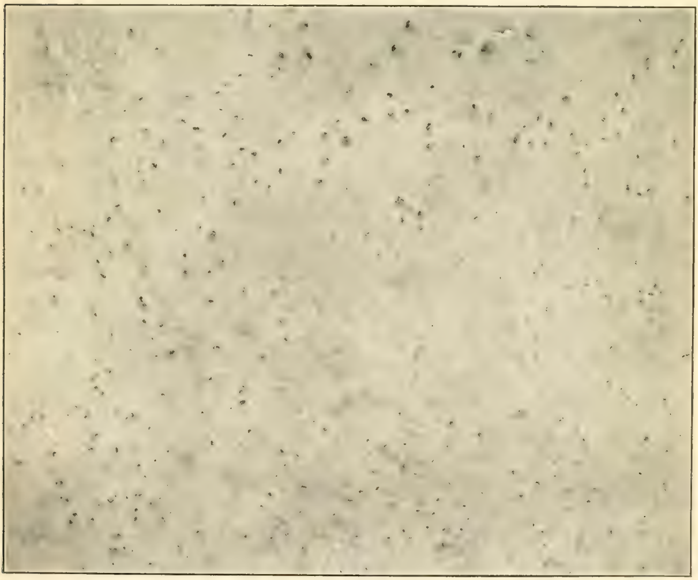
Figure 1 shows a clam bed artificially constructed in an immense field of thatch by removing the vegetation. Many of the roots of the plants still remain, however, and hold the soil firmly. Figure 2 represents a few feet of the surface of this bed, the numerous siphon holes indicating the great number of young supplied by parent clams living in the undisturbed thatch.

In the eelgrass, which grows between the tide lines as well as below, clams may also sometimes be found, but they are not numerous. Like the thatch, the eelgrass prevents the erosion of the bottom, but also probably makes it impossible for the clams to obtain a large amount of food, and, moreover, such areas contain a large amount of decaying vegetable matter.

FOOD AND WATER CURRENTS AS CONDITIONS OF CLAM GROWTH.

The food of clams is chiefly diatoms. Many species of these microscopic plants are attached to solid bodies, but those used by the clam for food swim and float in the water. Their number is enormously great, and their distribution apparently as wide as the seas, for they occur not only in all the shallow coast waters, but in the depths of the ocean as well. They form the food of many marine animals, but probably no forms are more completely dependent upon them than the group of mollusks to which the clam belongs. If one should follow a coast line, examining the water in every small bay and off every point, in every pool and eddy, and every swift stream, he would probably find diatoms constantly more numerous in some localities than in others. The reasons for this may be that salts in solution, which the diatoms use for food, are in greater quantity in one place than in another, and the differences in temperature affect the rate of reproduction, though this is usually a matter of some days. But whether or not clam food in a given volume of water is more abundant in one place than in another, some of it is present everywhere, so this condition of clam growth may be regarded as a constant one.

1. ARTIFICIAL CLAM BED.



2. SURFACE OF ARTIFICIAL CLAM BED.

It is true, however, that up to a certain limit, the number of clams which may exist on any area depends on the amount of food which they are able to obtain. Möbius has said concerning the food of the oyster, "The quantity of nourishment varies in proportion to the amount of water which passes over the beds." We will find that rapidity of current seems actually to have much to do with the number of clams which may exist on a given area. Besides this, evidence will be given to show that the increase in size of individuals depends upon the amount of food, that growth is much accelerated, and sexual maturity perhaps earlier attained where currents are swift. This of course is only possible where other conditions, such as the character of the bottom, are favorable.

In connection with the question of food and growth on natural beds, a word may be said concerning the existence of the soft clam below the low-water mark. The clam is almost always dug from beds that are exposed at low tide. Twice a day there is a period, of some considerable duration in some localities, in which the creature is unable to obtain food. It would seem that individuals below the low-water line, which are continually immersed, might thus have an advantage which should result in their more rapid growth. It is stated by Dean, in his study of the oyster in the South Carolina sounds, that "the best feeding conditions are during the rising of the tide, which appears to carry shoreward from the deeper water a number of pelagic forms. High tide contains the next highest percentage of oyster food. The poorest feeding conditions are shown at low water." But some feeding by submerged clams along the shore would be possible at low tide, and Mead gives experimental evidence to show that clams continually submerged actually do grow faster than those which are exposed at low tide.

In spite of the fact that food conditions are apparently favorable below the low-water mark, it seems doubtful whether submerged beds are relatively numerous. That there are many such beds along our coasts there is no question. They are present in the Essex River, in salt ponds east of Woods Hole, at West Falmouth, and one or two adjacent points on the shore of Buzzards Bay. Mead speaks of clams appearing in the market in February, 1900, which had been dug below low water in the Kickemuit River and at Wickford on Narragansett Bay. There are also beds at Salt Pond, Point Judith, and a large bed is known near Sag Harbor, Long Island. There are, no doubt, many more of these; but all these compared with beach beds may not be nearly so great in extent. This is a conjecture, and entertained only because, at many points, beaches have been examined and dug below the ordinary low-tide mark, at the full-moon tides, and apparently very few clams were present. It appears from a somewhat superficial examination, that clams on the ordinary clam beach extend down from the usual

high-tide mark to the usual low-tide mark, very few being found below this region. More evidence is needed on this point. If this belief is well founded, there is some adverse condition which is more or less general and which is not now apparent.

ORGANIC MATTER IN THE SOIL.

There must be a comparatively small amount of decaying organic matter in the soil where clam growth is to be maintained. The reason is that carbon dioxid and humous acids formed by the decay of organisms have the effect of removing the lime from the shells of clams and lead to their death.

THE EFFECT OF OVERCROWDING.

It is usually easy to find between the tide marks on natural clam flats certain areas which bear clams so thickly set that growth is extremely slow. Such beds may maintain themselves from year to year, but evidence will be given to show that their condition is precarious. If, for any reason, some individuals die, others may be affected and the contamination eventually leads to the destruction of all. Much depends upon the nature of the water currents. Where they are rapid the danger is least. Some areas, therefore, may bear many more individuals than others.

THE SALINITY OF THE WATER.

In describing the conditions which are necessary for the existence of clams on natural beds it may be well to note the fact that, within certain very wide limits, clams appear to do equally well in water which is very salt or nearly fresh. Not only is this true, but they may be transplanted from one locality to another where the salinity is very different without being affected adversely.

ENEMIES.

The enemies of the adult clam are few. At one point on the shore above Cape Cod, the gastropod *Nererita* was observed digging beneath the surface and devouring mature clams. That other animals attack them in their burrows has not been observed so far as I know.

From what has been said it is perhaps clear that there is much variation in the conditions existing on a clam flat, and that the necessary combination of circumstances to allow clams to grow and reproduce is positive and definite. These conditions restrict the distribution to certain more or less clearly defined areas. They are constantly changing also, and clam beds appear now in one place and then in another. There probably are many other factors in the problem of the clam's environment which have not been observed. It may not

be possible to discover them all even in an animal whose needs are so simple as the clam's, but a similar study of the conditions upon which an animal's life depends, if extended to other forms, would certainly give valuable knowledge in many cases.

CONDITIONS CONTROLLING THE DISTRIBUTION AND GROWTH OF THE YOUNG.

The egg of *Mya* unites with the male cell in the water. After fertilization a ciliated embryo is produced. This minute creature swims, and probably often is carried great distances by tide currents. Its early history has not been studied. Even after developing the bivalve shell it probably swims for many days before losing its cilia and settling to the bottom. The swimming larvæ may sometimes be taken in great numbers in a skimming net.

The habits of the young of *Mya*, from the time of settling to the bottom to the period when it finally digs into the soil to remain permanently, have been described.[a] The very small clam possesses a byssus thread. The byssus gland is probably developed at the time that the cilia are lost, for the creature needs this organ as soon as swimming ceases. The thread by which attachment is effected was seen in individuals that could not have been long upon the bottom. It is fixed to stones, aquatic plants, and other objects.

For some time the clam is too small to force its way into the bottom, though it early and persistently makes the attempt. A form with a shell which has attained a length of 5 or 6 mm. is able to burrow into almost any bottom. From the first the byssus may be cast off at will, and a new one produced. After attaining a lodgment a new byssus is formed and attached to sand grains and pebbles. In this way the animal is more or less perfectly anchored, and partially secured against dislodgment by waves or currents. It frequently leaves the burrow, wandering about by means of the greatly developed foot, and then repeats the process of burrowing. Finally it digs into the soil to remain permanently.

It is evident that the conditions determining the existence of the clam during this early period are different from those which affect the adult. The distribution of the young on the bottom and the subsequent struggle to effect a permanent lodgment are in some places peculiar. It may be well to consider these factors of the life problem apart from those which control the existence of the adult.

ENEMIES.

Floating organisms, very numerous in kind and infinite in number, constitute the food of a vast host of marine animals. Among these

[a] Observations on the life-history of the common clam. By James L. Kellogg. U.S. Fish Commission Bulletin, 1900.

pelagic forms are not only protozoa and protophyta, but also larvæ of higher animals. The swimming embryo of *Mya* has not been described as one of these, but most likely it also is subject to destruction in this way.

After becoming attached, and before it is possible to burrow, young clams are victims in great numbers to the rapacity of starfish. These pests begin their work of destruction while very young. They appear in the early summer, at the time when the young clams are falling to the bottom and struggling to obtain a lodgment. Some regions are much more subject to their ravages than others. Clams are not produced in equal numbers every year. In one year there may be great numbers, in the next very few. The same probably is true of starfish. Whether the conditions which allow of a heavy "set" of clams also result in the production of many young starfish is not known. It may be possible that this is not always so, and that in some seasons the young clams are comparatively free from the attack of their arch enemy. But some young starfish will always be present, and a few are capable of an immense amount of mischief. There is no doubt that, in the long run, the struggle of the young clams against this foe is a very severe one.

A few gastropod mollusks, such as the oyster drill, *Urosalpinx*, also prey upon young clams. Certain areas have been noticed where over 30 per cent of the small empty shells on the bottom have been drilled, but, although some small drilled shells are to be found wherever young clams are present, the losses from this source apparently are not often relatively great. Before the young clams are established in a burrow, other enemies, such as crabs and fishes, also prey upon them. The early life is a precarious one.

DISTRIBUTION OF THE YOUNG.

The swimming embryos settle to the bottom between and below the tide-lines. They are sown with a prodigal hand in shallow water and in deep, and only the very few fall upon "good ground" where they may have a chance to establish themselves. It is from these promiscuously scattered individuals that natural beds make good their losses. In certain restricted localities very great segregations of the young take place from accidental peculiarities of the surroundings. Their struggle for existence and their fate is interesting and instructive in many ways, and one such bed, which was observed with some care, will be described. It should be clearly stated that these thickly crowded beds are of very small extent as compared with natural beds of mature clams, and that they have no special significance, but are formed where conditions are peculiar, and usually disappear after a short existence. An attempt will be made to define the conditions which cause these peculiar segregations.

At West Falmouth, Mass., there is a small arm of the harbor which was found, in July, 1899, to contain vast numbers of small clams. No other locality along the shore seemed to possess many of them, although almost any clam beach at this time of the year showed a few individuals which had not long been settled there. They were found both above and below the low-water mark. Some very short strips just below low-water seemed to contain many small clams closely crowded; but though miles of the shore were followed, only two or three of these small patches were found. It is apparently only now and then that the conditions necessary for segregation are present. The beds at West Falmouth were extensive, and probably offered as perfect a field for the study of these segregations as could be found.

In order to explain some of the more important conditions, a figure of the small bay has been drawn. It is not perfectly accurate, but gives a fair idea of the ground. The bay is about 400 yards long. At its mouth it is about 40 and at its middle about 100 yards wide. The upper end of the bay widens considerably. It is probably nowhere more than 6 or 8 feet in depth at low-tide. One stream of water besides the inlet enters the bay. This is near its upper end, and is about 2 feet wide, the outlet of a pond of brackish water.

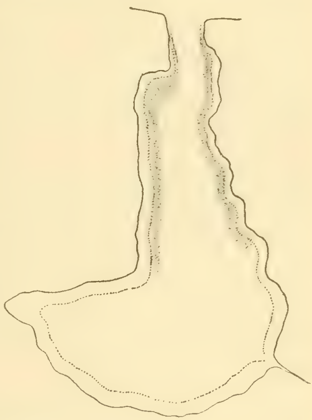


Diagram of beds of young clams at West Falmouth, Mass.

The heavy outline of the figure may represent the high-water mark, the dotted line mean low water. The stipples show the regions where the heavy "set" of young clams occurred. The lower half of the bay, between these lines of clams, was choked by a close growth of eelgrass. The wide upper end was covered with a soft oozy mass of fine sediment.

As shown by the stipples in the diagram, the small clams were distributed in two long strips below the ordinary low-tide mark, and parallel with the shores. These strips were nearly 200 yards long, and between two and three yards wide. The clams extended nearly to the eelgrass. They were nowhere present in the broad part of the bay, farthest from its mouth, nor were there any adult clams between the tide marks in this region. Adult clams were fairly abundant between tide lines opposite the young, near the opening to the bay.

On examining the tide currents it was found that there were two comparatively swift streams, whether the tide was rising or falling,

which ran parallel to the shores, over the area occupied by the small clams. The current in the center of the bay was slow, on account of the great mass of eelgrass which filled it, so that a large part of the water entering and leaving took this course near the shores. These streams seemed to be like that part of a river which has reached its base level, for apparently they neither deposited nor eroded. In the broad upper part of the bay the water was quiet and a large quantity of fine silt was deposited, making it impossible for clams of any age to exist.

It is probably generally true, as in this case, that small clams are found crowded in great numbers only where currents are comparatively rapid. This has seemed to be the condition in other localities where they have been found. At the lower ends of these strips they were crowded most closely, and the currents were most rapid here, though still not so swift as to disturb the bottom. Toward the upper ends of the strips clams became gradually less numerous, where, also, the velocity of the currents was diminished.

It is important to notice that the small clams were not entirely confined to the beds below the low-water mark. With a fine sieve it was possible to find them between tide lines. They were not numerous, however. It has been stated that the densely packed beds below low-water mark appear in few localities. Yet from almost any clam bed between tide lines in the early summer a few of the young may be obtained. The number is insignificant as compared with that where young clams are segregated in a bed by themselves. It is probably these scattered young that make good the annual losses of a clam bed, and not the numbers of the crowded lower bed, even where it is present and in close proximity.

Such a separation of young below low tide and adults between tide lines as shown at West Falmouth seems strange, and the further history of this lower bed is equally remarkable.

We may attempt to explain the position of the young in the following way: For several weeks during the breeding season in 1889 (May, June, and July), when this large "set" occurred, the embryos undoubtedly swam in vast numbers in the water. It is probably safe to say that during such a season millions of embryos grow from the eggs of a single large female. These embryos swim, and it is possible that the course taken by them may be influenced by differences in the intensity of light, changes in the temperature of water or air, or by differences in the specific gravity of the water. But their movements must be very largely determined by tide currents, and it is not easy to imagine that these other conditions are the causes of this peculiar distribution, or that they have any important influence upon it.

We will probably find our explanation in the action of a definite current of water which contains swimming embryos. Imagine a wide

stream entering the mouth of this bay. It carries embryos which it has received from beds outside. At high water embryos are added, also, from beds of mature clams inside. The incoming stream is checked by the eelgrass in the center of the bay. Much of the water is deflected to the sides, and a much larger quantity of it passes over the bottom there than elsewhere. That is to say, very many more embryos are borne over this line parallel to the beach than anywhere else. When the tide runs out it takes the same course as on entering, and for the same reason.

We may suppose that for several weeks embryos are continually dropping to the bottom, losing their cilia, and attaching themselves by the byssus. That this strip receives accessions of small clams for several weeks will be demonstrated. Evidently, then, many more would reach the bottom here than elsewhere. At the same time a few would fall upon the eelgrass or on the bottom on which it grows, and some would also find lodgment between the tide lines at the end of a flood and the beginning of an ebb tide. This may account for the distribution in this bay, and in similar cases observed there is also a swift, narrow current.

In the summer of 1899 this set of small clams maintained itself for some little time, the reason being that sediment was not deposited over this area. No doubt great numbers of embryos carried into the wide upper part of the bay also settled to the bottom there. But they were unable to establish themselves and undoubtedly perished, because the slacking current deposited silt, and quickly smothered them. None were found along the shores of this part of the bay. This soft deposit was probably often agitated by unusual tides, or even by rains or strong winds. It is possible for the clams to live only where a current is running with a velocity great enough to prevent a deposit.

These facts seem to be sufficient to account for the distribution and maintenance of young clams, but it may seem strange that similarly crowded areas were not found more often when a search was made for them near many other clam beds. But even when the currents were favorable, the embryos in the water, although deposited in the same manner, may have been so few in number as to escape observation.

The conditions governing clam distribution are in some respects similar to those determining the set of oyster spat. The swimming young of the oyster fixes firmly to foreign objects. Its distribution is often perplexing. Sometimes, as in parts of Long Island Sound, the attachment takes place in deep water. On the "coon" oyster banks of the South Carolina sounds, attachment rarely occurs below low-tide mark. In some regions the set is at one time high, at another time low.

Several suggestions have been made in an attempt to explain these peculiarities of distribution. They include the influence of varying

density of the water, the softness of the bottom, the suspension of silt in deep water, and changes in the composition of the water of oyster beds. Dean[a], who carefully studied the problem, concluded that the slime-covered bottom probably prevented fixation, and that silt suspended in the water made it impossible for the oyster to live, these being the chief factors of the distribution.

The habits of the young oyster and of the young clam are very different in many respects, but the segregation in both cases to definite and limited localities is probably from the same cause. Over any area a greater number settle to the bottom where currents are swift. At the same time, many sink on other parts of the bottom. Wherever silt is absent either may become established; in a silt deposit neither can live. The favorable localities may be near the shore or in deep water, as the case may be. In some places the presence of enemies must also be considered.

We may conclude that on a clam beach or flat, embryos settle to the bottom both above and below the low-water mark. Fewer embryos lodge above the low tide line than just below it, because of the recession of the water. Where definite currents are present we find the greater number of the young. Where currents keep the bottom clean but do not erode, clams are for a time able to establish themselves. In distributions like this one at West Falmouth it may be asked what is the relation between the two separated beds of clams. The answer may be given with some certainty that there is none. It seems probable that the mature clams between tide lines are recruited only slightly, if at all, from the beds lower down, and that their number is added to by the small clams which, in the beginning, settled between the tide lines and were able to establish themselves. The multitude constituting the lower bed seems ultimately to perish.

The bed of young clams was first found at West Falmouth on July 10, 1899, and during the remainder of the summer was examined often. On this date clams were very thickly set. Numbers of them were small, many being about 1 mm. long, while the maximum length was about 11 mm. The clams shown in figure 3 were selected from a large number to represent the minimum and maximum sizes of those on the bed, and also, as nearly as possible, the relative number of intermediate sizes. No doubt many smaller than those represented were lost through the meshes of the sieve.

The ages of these clams can only be conjectured. The larger are probably from 5 to 7 weeks old; the smaller may have lived 1 or 2 weeks. The breeding season in Buzzards Bay extends from the latter part of May to the early part of August, reaching its height in late June and early July. Here and there very small clams are found as

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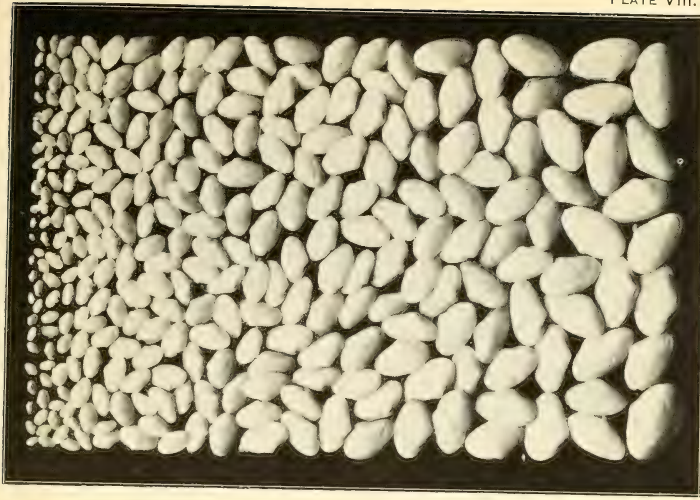
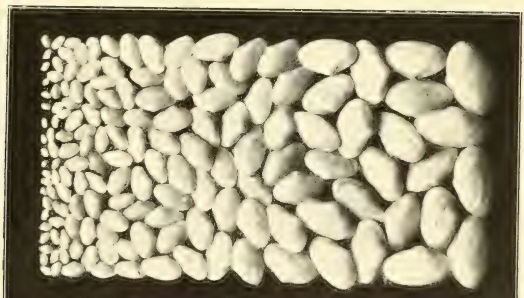
[a] The Physical and Biological Characteristics of the Natural Oyster Grounds of South Carolina. By Bashford Dean. Bulletin of the U. S. Fish Commission for 1890.

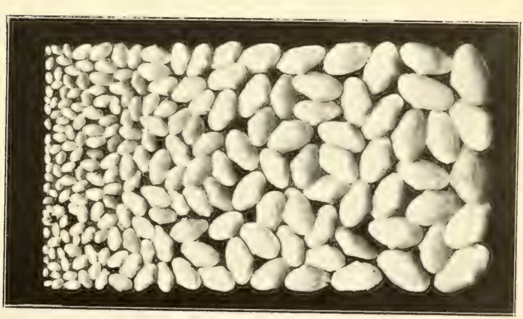
PLATE VIII.



5. July 27, 1899.



4. July 17, 1899.



3. July 10, 1899.

SIZES OF CLAMS FROM BED AT WEST FALMOUTH, MASS.

late as September, but after the first of August the number diminishes rapidly.

Figure 4 represents clams taken in the same way on July 17. There still appear individuals as small as on the previous date, but they are less numerous. The larger ones had attained a length of about 13 mm.

On July 27 another lot was taken and is represented in figure 5. At this time very small clams still seemed to be making their appearance, and there is an increase in the maximum size.

On August 4 (fig. 6), clams but recently settled to the bottom were not numerous. The maximum length was about 18 mm.

Figure 7 shows individuals taken on August 16. There were still found at this time a very few that had recently settled to the bottom. The maximum size was about 20 mm.

When the beds in this bay were first found on July 10, there were already so many empty shells lying on the bottom that they formed a white line which could easily be traced for some distance by one standing on the high bank. Many of these, however, were of previous generations. As time went on, more and more empty shells appeared, until in August the surface of the bottom over the beds was covered with them.

It appeared, then, that even well within the breeding season, when embryos were still settling to the bottom in great numbers, the destruction of the beds had begun. On July 10 numerous dead shells were found in the bottom as well as on its surface. Many of these, too, were clearly not shells left from some previous season, for they were found with the organic matter of the body not yet decayed. The death of individuals spread rapidly, until, on August 16, a square foot sometimes yielded no more than half a dozen live clams. By September 1 practically all were dead. In the meantime on the beach above the mature clams were holding their own fairly well, but it is a significant fact that digging during the second week of August showed that many of them also had recently died.

It is not easy to explain this complete destruction. During this same summer Mead was studying the same phenomenon at Wickford, R. I. He says: "In one case a certain point of the shore was set in the middle of July as thickly as the clams could burrow, but by the month of August hardly a young clam could be found. They apparently washed out or were covered with shifting sand. In another locality, about 40 rods from the last, the set was also very thick. These clams continued to be abundant throughout the summer and autumn, and, though meanwhile they were somewhat thinned out, were yet very numerous on December 4. I think one important factor in their wholesale destruction lies in the fact that they set much thicker than they can grow, and a great many are crowded out."

It has been stated that a careful examination of the West Falmouth

beds gave no evidence of an erosion of the bottom. Even the light empty shells on its surface were not moved to any extent by the currents, so that clams in these beds nowhere seemed to be washed out or covered with sand. There were places, it is true, where they were so closely crowded as nearly to touch each other, but over the greater part of the beds there was ample space for all. Yet everywhere the same destruction occurred. Mead's explanation did not apply here.

Almost everywhere among the empty shells on the surface living clams were found. Even when 20 mm. in length, a clam is ordinarily able to cover itself in the course of a few minutes, and smaller ones are more active than the larger. Small clams have been described in a previous paper as being restless and as having the habit of coming out of their burrows, wandering for short distances, and again digging into the sand. Yet these individuals among the empty shells usually seem to be inert.

The following explanation is offered for the destruction on these beds. The small clams are constantly coming to the surface of the bottom. When exposed they are subject to the attack of starfish, crabs, and fishes, and though these enemies were very scarce here, some clams may have been destroyed by them. Because so many of those lying among the empty shells could not be revived on being removed to what appeared to be more favorable localities, but remained motionless until they died, we may suppose them to have been greatly exhausted from lack of food. The wandering habit of the small clam will account for the appearance of so many dead shells on the surface where there is no crowding or washing out. It was stated that a very large number died in the burrows also. If lack of food is the explanation for the beginning of the destruction, however, there must have been a time, after the death of a certain proportion of the whole number, when food in the water was sufficient for the remainder. As these grew and each demanded more nourishment, others would die, until a new equilibrium was established. Instead, almost complete annihilation occurred.

Another factor may have entered into the problem. The contamination of the water, by the bodies of so many dead, finally may have caused the death of all. This is suggested because on several artificial beds in which the clams were closely crowded the destruction of all seemed to occur from this cause.

The assumption that lack of food and the spread of infection from dead clams were the causes of the extermination seems to be confirmed by the fact that death apparently occurred first where clams were most crowded, and spread from those points. By September 1 almost every clam was dead at the lower ends of the beds, nearest the mouth of the bay, where they had been most closely set, while at the upper ends, where they were scattered, several still survived.

It is not clear why, in this case, the mature clams on the beach above the low tide line escaped, though the water flowing over them possibly may have contained sufficient food for so small a number, and the contaminated water would remain largely in the rapid stream over the lower bed, both on the ebb and flood tide. A number were found dead, and the beaches were dug very little by clammers, who might have injured many so as subsequently to have caused their death. Very likely other factors not observed entered into the extermination of the small clams.

VARIATION OF THE SET OF DIFFERENT YEARS.

Much attention has been given to the production of oyster seed. In Europe and in the United States it has been found that the productiveness varied greatly in different seasons. There is nothing regular about it. Favorable and unfavorable seasons may alternate for a time, or there may be a succession of productive or unproductive years. Möbius[a] says: "In 1860 there were many young broods upon the beds near the island of Ré and near Rocher d'Aire and but few broods at Arcachon; 1861 was a good brood year for all three places; 1862, bad for the island of Ré and good for both of the others, and in 1865 there were very many young in the bay of Arcachon and but few near Rocher d'Aire and the island of Ré. The causes of these variations are thus local in their action, but what they are is not fully known, beyond the fact that a definite density of the water is most favorable for egg laying in the European oyster.

There has been no accurate study of the spawning of the clam. The variation in the size of the set is, however, much like that of the oyster. While the young in 1899 appeared in great numbers along the shores of Buzzards and Narragansett bays, in 1900 they were very scarce in both localities. At Duxbury and Essex the set was said to be favorable in 1900. These places are north of Cape Cod, where the biological conditions are very different from those on the south side. The conditions seem to be local.

The variation of the set may be due to the fact that few or many ova are produced at different times, or it is possible that eggs are always abundant, and that at times some unknown condition prevents the swimming embryos from establishing themselves on the bottom. It is not yet possible to say what effect the degree of salinity of the water has upon the production of the sexual elements of the clam, or upon the development of the embryo. It is probably little, because, unlike the oyster, the welfare of the adult clam is not determined by a limited and definite density.

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[a] Die Auster und die Austerwirthschaft. Karl Möbius. U. S. Fish Commission Report for 1880.

RATE OF GROWTH OF THE YOUNG.

When figure 8 is compared with figure 7 it is seen that the increase in five weeks is considerable. The maximum length on July 10 was 11 mm., on August 16, 20 mm. It must be remembered that during this period the number on the beds was enormously great. In one region, where clams seemed to be most crowded, a count showed an average of 1,100 to the square foot on July 10. With so great a number the food supply must have been inadequate. Growth probably would have been much more rapid if food had been more plentiful.

Several thousand clams were removed from these beds on July 27 and planted below low-water mark at Woods Hole at a point where conditions seemed to be favorable. They were placed in a swift current where no other clams were present. For some reason the great majority soon perished. Mead showed that clams planted in a box of sand suspended in the water from a houseboat grew faster than those which were crowded on the beach.

CONDITIONS DETERMINING EXISTENCE, AND THE RAPIDITY OF GROWTH ON ARTIFICIAL BEDS.

It has been shown that there are certain definite conditions which are necessary for growth on natural beaches and flats, and that when these conditions are not present clams can not live. It has also been stated that the distribution of the young on the bottom depends upon peculiar conditions of the environment. We may now consider a series of experiments designed to test these observations. They will show also that the artificial rearing of clams may be accomplished with little labor and at small expense. Oyster culture in the United States, though much more simple in its methods than in Europe, is many times as difficult and expensive as clam culture would be, and in the present depleted condition of our shores clams are sometimes worth nearly as much per bushel as oysters.

From the foregoing description of the small clams, it is evident that a study of such cases will not demonstrate the possibilities of clam growth. The conditions of growth are most unfavorable on beds so greatly crowded. Early in the summer of 1899 a number of artificial beds were prepared, and during the summer many thousands of clams were planted upon them. Beds were placed in various localities where the surroundings were different, and each was left undisturbed for a year.

The main objects of the experiment were to determine the rate of growth under as many different conditions as possible—in slow as compared with rapid currents; in closely crowded and thinly planted beds; the relative amount of growth of small and large clams; growth after exposure for different periods; growth after a transfer from brackish to salt water, etc.

6. August 4, 1899.

7. August 16, 1899.

SIZES OF CLAMS FROM BED AT WEST FALMOUTH, MASS.

8. INCREASE IN VOLUME AFTER ONE YEAR OF CLAMS FROM EXPERIMENTAL BED WITH PRACTICALLY NO CURRENT.

Any facts bearing on the length and variation of the time required for reaching the period of sexual maturity in animals should be of scientific interest. The conditions determining the length of this period are known in few animals, and speculations like those, for example, on the meaning of the duration of their life can not safely be indulged in without many more facts of this nature. It certainly seems to be true in this case, as in that of the accelerated growth and maturity of oysters in French claires, and of the young starfish studied by Mead[a], that the amount of food determines whether the period shall be long or short. The question of the growth of clams has a severely practical side also. In any attempt to rear them for commercial purposes, rapidity of growth is the most important thing to be considered. On it depends, to a large extent, the practicability of culture methods.

Many years ago, when the oyster supply began to decline in Chesapeake Bay, and an increasing demand caused prices to rise, the life history and habits of the form were studied and various methods of artificial culture devised. These have been practiced for some time with great success on the north Atlantic coast. It is found that, under favorable conditions, a marketable size is reached after a growth of three or four years. In Europe this period is sometimes shortened to a considerable extent by improving the food supply. Great profits are realized, even when that length of time is consumed in awaiting the harvest.

The period of growth in the soft clam is much shorter than this. A growth of two years, under fair conditions, should produce a clam of marketable size, and culture methods are very much simpler and cheaper.

THE DECREASE IN THE SUPPLY.

For nearly a quarter of a century the clam supply of the north Atlantic coast has been steadily declining. During the last five years it has fallen off very rapidly, and in many places the industry is nearly destroyed.

In the report of the U. S. Fish Commission for 1894, statistics are given showing the production of clams in New England from 1880 to 1892. These tables are valuable, because they indicate a great decrease in the market sales, and in a case like this it is impossible to obtain statistical evidence of the condition of the beds in any other way. Yet statistics are not always conclusive. In this case, for example, the tables for the State of Maine show an increase in the production from 1880 to 1887, in the former year 318,383 bushels being marketed, and in the latter year 608,780 bushels. From that time until 1892 they indicate a steady decrease to 416,806 bushels. But there was not so great

[a] Twenty-ninth Annual Report of the Commissioners of Inland Fisheries of Rhode Island. 1899.

a decrease in the actual supply on the beds, for since that time sales have increased, until in 1898 Maine marketed 1,109,936 bushels.

This is mentioned to show that, while a table of market sales usually may indicate the condition of the beds, there may be some cases in which it will not. An examination of the beds themselves, however, can give only an approximate and incomplete estimate of their condition. Where this has been done the indications are that, with the exception of the state of Maine, these tables gave a correct estimate of the conditions of clam beds in the New England States at the time of their compilation, and that the decrease has been more rapid since that time. Long Island, too, is fast repeating the experience of New England. Even in Maine, the beds now seem to be suffering from excessive digging, and the State, in 1899, passed a law prohibiting the sale of clams in any form from June 1 to September 15 of each year. From a practical standpoint, then, there is great need that the conditions of growth be determined by experiment.

EXPERIMENTS.

METHODS EMPLOYED.

The beds for the experiment were laid out at Woods Hole. The locality was not the most favorable that might have been selected, for the beaches are narrow and almost everywhere stony, making digging difficult, and the rise and fall of the tide is not great. These conditions made planting and the removal of clams very difficult also, and clams for planting were not easily to be obtained in the vicinity. The locality was chosen because certain short strips of beach are controlled by the U. S. Fish Commission, and upon them trespassing could be prevented. Because conditions of growth were unfavorable, however, it is certain that the results obtained here could be realized almost anywhere where clams will grow at all.

Clams to be planted were collected from many parts of Buzzards Bay and Vineyard Sound. Some were dug at West Falmouth, others at Mattapoisett and Hadley Harbor, while a great many were taken from the brackish waters of Long Pond, east of Falmouth Heights.

The plan was to prepare beds by digging clams already in the ground, and to plant small clams which should be left for a year before being removed. The length of these clams was determined by a measurement of every individual. They were measured in eighths of an inch. Those of a size were collected and planted together.

It was necessary that there should be some means of determining positively, when finally removed, the exact position of clams whose size had been determined at the time of planting. A method by which this was most successfully accomplished was devised by Dr. H. C. Bumpus. On a selected area, four posts were driven inclosing a space

10 feet square. A light, portable frame of the same dimensions was constructed and divided into square feet by means of small ropes. At the time of planting, this frame was placed upon a bed, just fitting between the stakes, and clams were placed in any of the small squares, a record of size and number being made in the corresponding square of a diagram in a notebook. When clams were removed the frame was again placed in its original position.

It should be said that clams of the size of those planted do not remove themselves from their burrows, but remain where they are placed. It has been stated that small individuals wander, but the habit seems to be abandoned before they are an inch long.

As already explained, clams were measured in length before planting and again after a year of growth, to determine the increase. A statement of the increase in length gives no adequate idea of the actual increase in size, however. This increase in volume was determined by displacement in water. A clam 1 inch in length diplaces approximately 2.25 cc. of water. One 2 inches long displaces about 11 cc., or nearly five times as much. An individual measuring 3 inches displaces about 43 cc., or is about nineteen times as large. In measuring displacements, results vary in different cases. Some individuals are thick and wide, others narrow in proportion to the length of the shell. When being measured some are more contracted than others. Thus a comparatively large number was measured in order to determine the average displacement in each set, and the results obtained are accurate enough for the purpose.

In order to be certain of the position of individuals in the beds, a sharp-pointed stake was driven into the ground to a depth of several inches, and on its withdrawal a clam was thrust siphon end uppermost into the hole. Working in this manner, it was possible to place them with some rapidity. Upon a hard, gravelly beach, four men at one time planted 3,000 in two hours. In a soft beach twice that number might have been planted in the same time. There seems to be no reason to doubt that clams finally removed from any square were the ones originally placed there. The beds were probably not molested by clam diggers. There was some apprehension lest, during the winter, ice should destroy the stakes marking the corners of the beds. Fortunately not a stake was removed or broken.

Clams all of the same length when planted will of course vary somewhat in size after a year's growth. When these were dug, they were again measured and arranged in a series of different sizes, the number in each set being counted. The arithmetical mean of the series was then determined. The volume of the mean of the series was compared with the volume of the clams when planted, and the percentage of increase in volume calculated. For example, in a certain bed planted on July 13, 1899, the clams were $1\frac{1}{4}$ inches long. They were removed

on July 4, 1900. The mean of this series, expressed in eighths of an inch, was 20.952, or nearly $2\frac{5}{8}$ inches. The volume of a clam $1\frac{4}{8}$ inches long is 4.5 cc. That of an individual $2\frac{5}{8}$ inches in length is 32 cc. Hence the increase in volume is about 688 per cent.

RESULTS OF THE EXPERIMENTS.

It should be remembered that on many of the beds, especially upon several which were placed near the upper end of the small harbor at Woods Hole, conditions of growth were not favorable. About the middle of July the pebbles and stones on the surface were coated with a dense growth of the seaweed *Enteromorpha*. Diatoms, which form the food of clams, are to be found in great numbers among the threads of this alga, but the mat was so dense that it must have interfered seriously with the process of obtaining food from the currents. Great masses of dead eel grass, which was barely floated at high tide, also remained upon the beds for days at a time during the summer, and must have interfered greatly with the food-bearing currents.

Increase with practically no current.—Many thousand clams were placed in the beds at the head of the harbor. These, for the reasons mentioned, yielded the smallest proportionate increase, and may be considered first. The following table illustrates the amount of growth of several sizes on the poorer beds:

Size when planted.	Approximate percentage of increase in 1 year.	Size when planted.	Approximate percentage of increase in 1 year.
	Per cent.		*Per cent.*
$1\frac{3}{8}$ inches	556	$2\frac{1}{8}$ inches	139
$1\frac{4}{8}$ inches	422	$2\frac{2}{8}$ inches	109
$1\frac{5}{8}$ inches	347	$2\frac{3}{8}$ inches	78
$1\frac{6}{8}$ inches	284	$2\frac{4}{8}$ inches	38
$1\frac{7}{8}$ inches	210	$2\frac{5}{8}$ inches	28
2 inches	190		

Figure 8 presents to the eye the increase of volume in the set $1\frac{5}{8}$ inches long. The jar to the left holds 75 individuals of that length, while the other contains an equal number the size of the mean after growth—$2\frac{4}{8}$ inches. The increase in volume is 347 per cent.

In making these estimates of growth there is in each case a slight inaccuracy, but it is apparent that in comparing relatively small series, or even large series, to show the increase, absolute precision in all the details of the calculation would be no more to the purpose than are these figures. For if a similar experiment were carried on with equally exact detail in a region where conditions of food, time of exposure, etc., were slightly different, the results would vary from those obtained in the first case, *and we can not determine the varying possibilities of different conditions or surroundings* with any knowledge

which we now possess. Here we simply describe the conditions so far as we know them and show the approximate increase, and the number of clams planted (8,500 in the 17 beds) is great enough to make our result reliable.

The errors are slight. They arise in two or three ways, and tend to balance each other. (1) The unit of the scale of measurement was an eighth of an inch. If a clam being measured for planting was slightly less than $1\frac{1}{8}$ inches in length, it was placed in the 1-inch group. This method was also followed in measuring clams after growth. (2) When the mean of a series after growth was determined, a decimal above 0.5 was expressed by the next highest, and when below 0.5 by the next lowest unit in the scale. Thus if the mean size in a given series were 20.6 eighths, it would be called $2\frac{5}{8}$, if 20.4, $2\frac{4}{8}$ inches.

The decrease of the percentage of growth shown in the table, from the smaller to the larger individuals, is not perfectly regular. This may have been because the number in some series was much greater than in others, and also because the conditions on one bed were not exactly like those on another. Some beds were each day longer exposed than others, and there may have been other differences in the surroundings.

Amount of variation in a single series.—The variation in length of the individuals of a single series was considerable. For example, in a series of 140 clams, which were $2\frac{4}{8}$ inches long when planted, the series when dug included clams from $2\frac{6}{8}$ to $3\frac{3}{8}$ inches in length. A few seemed to have grown very little. It is possible that some may have been overlooked in preparing the beds for planting, and that these clams were not those planted, but small forms already present and not removed. From the pebbly nature of the surface it was not easy to detect all the siphon holes. On account of the difficulty in removing all small clams in preparing the beds, these afterwards appearing in the series, probably the calculated percentage of growth is less than it would have been if the beach when planted had been perfectly clear of clams. On the other hand it was comparatively easy to note the presence of large clams, and probably few of them were left.

In one bed in another locality the ground was most carefully dug and examined for small clams. Practically all must have been removed. The clams planted here were all exactly 1 inch long, but at the end of a year the length varied from $2\frac{1}{8}$ to $2\frac{7}{8}$ inches.

Growth in a slow current.—Over the beds first described there was practically no current, but only a rise and fall of the tide. The following table, prepared as was the first, shows the approximate increase on several beds placed on a beach near the entrance to the harbor, where the current was more marked than at its head. The current here, however, was not at all strong, and was discerned only by the bending of the eel-grass below the beds. On the best clam bottoms in

other regions it is many times as great, yet the difference between these two localities was great enough to make a decided difference in the rate of growth.

About 5,000 clams were planted here, but unfortunately for our comparison with the other beds, most of them were of smaller size than in that region. A very large number, however, were $1\frac{3}{8}$ inches long when planted, and many of this size were placed in the beds already described. In the first case the approximate increase in clams of this size was 556 per cent, in this region 711 per cent.

Size when planted.	Approximate percentage of increase in 1 year.	Size when planted.	Approximate percentage of increase in 1 year.
	Per cent.		*Per cent.*
1 inches	1,150	$1\frac{2}{8}$ inches	768
$1\frac{1}{8}$ inches	802	$1\frac{3}{8}$ inches	711

We find, as would be expected, that the percentage of growth is greater in the smallest clams planted. In the first table, clams $1\frac{3}{8}$ inches long when planted, increased 556 per cent in the year, while those $2\frac{5}{8}$ inches in length increased 28 per cent in the same time. This is illustrated in figures 9 and 10. In each figure the upper clam is of the size planted, the lower the size of the mean after a year's growth. The clams in figure 9 were planted in a more favorable locality than in the other case, but the result would have been much the same if both had grown on the same bed. Under the most favorable circumstances a growth of several years must be necessary to produce a 6-inch clam—and individuals of that length are sometimes found.

A point of practical significance in this connection is that clams from 1 to 1.5 inches in length, which are much too small for sale, may, in the course of a year, when not too greatly crowded, reach a fair marketable size. Now on most clam beaches and flats areas are to be found on which these small clams are so closely crowded that growth is hardly possible. Sometimes these areas are suddenly depopulated, and sometimes they exist for years with little increase in the average size. If these clams were dug and properly spaced, the increase would certainly be very great. There would usually, of course, be no object in planting clams much more than 2 inches long.

The spacing of clams.—Another fact must be noticed in connection with the increase shown in these tables. All these clams were planted close together for this region. Five were placed on every square foot. The beds, also, and there were 17 of them, were all placed as closely as possible. Without doubt if the clams had been more widely spaced growth would have been still more rapid. A good clam ground would probably support several times as many as this.

9. Increase in size in one year of clam 1 inch long when planted.

10. Increase in one year of clam $2\frac{5}{8}$ inches long when planted.

CLAMS FROM EXPERIMENTAL BED WITH MORE MARKED CURRENT.

It is evident that no general rule can be given for the spacing of clams. Where food-bearing currents are rapid clams may be closely placed, and where they are slow the spacing must be greater. Only experiment will determine the optimum space for a given area.

The proper number of clams to be planted on any area can not be expressed in bulk measurement. In an early note on the Essex experiment in clam culture[a], it was stated that clammers estimated that 500 bushels of small clams would be necessary for planting 1 acre. Suppose that clams to be planted varied from 1 to 2 inches in length, and that all were to be left until of marketable size. If planted in the same locality they would require an equal spacing. But assuming that 1 bushel contains 4,000 clams 1 inch long, it would require nearly 7 bushels to hold 4,000 clams 2 inches long, and the single bushel of the first should be spread over as great an area as the 7 bushels of the larger size. Even if beds were of the same character in all places the proper number to be planted could not be expressed in bulk measurement.

There remains to be described the growth on a special bed with which extraordinary pains were taken. This bed was selected at a point slightly below those the increase of which has been described in the second table. The current was here more rapid, and the clams were each day immersed for a somewhat longer time. The bed was all very carefully dug, that it should bear no clams not measured and planted. In it were placed several hundred clams exactly 1 inch long. They were in good condition when planted on August 17, 1899. To protect the bed a wire netting was firmly fastened over it, being attached to iron posts and held down in various places by long wire staples. The bed certainly was not touched for a year.

On August 16, 1900, the clams were removed. Their length varied from $2\frac{1}{8}$ to $2\frac{7}{8}$ inches. The arithmetical mean of the series was 18.969 eighths, or almost $2\frac{3}{8}$ inches. Comparing the volumes of clams of 1 inch and $2\frac{3}{8}$ inches it was found that the latter was 14.37 times as large as the former, or that there had been an increase of 1,337 per cent in volume. This amount of increase is represented in figure 9, and was the greatest obtained on any of the beds.

On the beach above, where the current was not so rapid and the time of exposure greater, clams of the same length increased in volume but 1,050 per cent. It appears, then, that rapidity of growth depends directly upon the amount of food, the food supply depending upon the velocity of the current.

This growth took place upon a beach and not upon a flat where currents have full sweep. A feeble current ran parallel to the beach, but the bed itself was partially surrounded by eelgrass. The food supply here must have been poorer than upon many clam flats, and it should

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[a] Report of the U. S. Fish Commission for 1894.

not be difficult to obtain even a more rapid growth in the most favorable localities.

Comparative growth on high and low beach.—Several thousand clams were planted in rows extending from the high-tide mark to a position some distance below ordinary low water, in order to determine, if possible, the relative effects of long-continued submergence and frequent exposure. Unfortunately the attempt failed, because, in ignorance of the number which a given area would support on these beaches, the clams were placed so close together that they all died. That fact itself is one of the most important demonstrated by these experiments, and will be mentioned later.

Among the 17 beds at the head of the harbor were several which were exposed only at full-moon tide. It is a curious fact, for which there is no apparent explanation, that in almost all of these the greater number of clams died. They were not more thickly planted than on higher beds, though their average size was slightly larger. On the other hand, as already stated, a very rapid growth was obtained in another locality on a bed placed near the ordinary low-water mark, the lower part of it usually being submerged.

Death from overcrowding.—This may be due, as in the case of the small clams, to two things—the lack of sufficient food and the contamination of the water by the decaying bodies of dead clams. When a clam dies others near it seem to be affected. When several die the infection seems to spread rapidly, so that the death of a few may lead to the sudden destruction of many or all in the vicinity. To illustrate this, two beds were planted thickly (9 to a square foot) with clams $1\frac{3}{8}$ inches long. Among these were a few individuals which were nearly dead from exposure. Their bodies probably quickly disintegrated. The majority in each bed were apparently in the best condition.

One of these beds was in comparatively quiet water; the other where currents were constantly running back and forth over it. A year after planting, the first bed contained no living clams. The shells of the dead were easily found, though in some cases nearly disintegrated. When measured they were found to be, without exception, the size of those planted. This indicates that the few injured clams died at once after planting and that the contamination spread rapidly, all being destroyed before any had grown.

The other bed, in the more rapid current, contained a few living clams. A great number of empty shells was found, but these were not all of one size, as in the first case. They exhibited a gradation from the size of the living forms, which were the largest, to shells of the planted clams. The condition of this bed probably is to be explained by the supposition that the early death of a few injured forms did not immediately affect all the others, this being prevented

by the rapidity with which the currents carried away decaying matter. Growth may have continued until, from the effects of crowding, others died, and this process finally left only the few.

Two other beds may be cited as illustrations of this point. They were placed on the same beach where the most rapid growth was obtained. Each contained 150 square feet and extended from near high water below ordinary low water. In the first, 1,900 clams were planted, varying from 1 to 1¼ inches. In the second were placed 1,200 clams of the same sizes. All seemed to be in perfect condition.

In a year's time almost all were dead on both beds. An examination revealed shells of all sizes up to about 2.5 inches. The few living clams were nearly 3 inches long. The great majority of the empty shells were very little larger than those planted, so that death must have overtaken them soon after being put in the ground. Death from lack of food or from injury may have occurred in a few individuals. The decaying bodies of these may in turn have caused the death of others, and this must have come about quickly.

Which is more important in accounting for this destruction, lack of food or contamination of the water, it is difficult to say. Scarcity of food alone may account for it up to a certain point, as explained in connection with the death of small clams on natural beds; but finally there should have been a certain percentage remaining for which food in the water was sufficient. Nearly all died, however, and it is not easy to see why they should, unless it may have been from this infection of the water by the bodies of dead clams. At all events there are several cases to show that too great crowding is likely to lead to the loss of all clams planted together. Where currents are rapid more clams may live than where they are slow, and the capacity of any beach or flat must be determined by experiment.

THE CHARACTER OF THE BOTTOM INFLUENCING GROWTH.

Natural beds are found on muddy, sandy, or rocky beaches. Whether soft or hard, the bottom merely offers protection from enemies. Buried under several inches, the clam reaches to the surface with its siphons. Through them one current of water bearing microscopic food is led down to the body within the shell and another passes out bearing waste matter.

It may be assumed that the abundance of food in the water is the only important feature of the surroundings, but, in some ways, the character of the soil may also be important. Two beds were marked in a soft bottom which contained much decaying vegetable matter. Other conditions seemed to be much as in the neighboring beds. The surface of this peaty mass did not shift. Water currents, food, and exposure by tides were certainly not very different on other produc-

tive beds 50 yards away on the same beach. But of 1,500 clams planted in perfect condition, apparently, only 3 remained alive. It was found, too, that they had not all died at once from the contamination of the water by dead clams, for many shells were found larger than the size planted. Most of the shells fell to pieces at a touch, being disintegrated by the humus acids and carbon dioxid formed in the decay of vegetable matter. In this case the shells may have been destroyed by the acids faster than they could be built up by the animal, thus leading to the death of the clam. In several other beds where decaying matter was present in the soil, a partial disintegration of the shells of living clams was very noticeable.

On clam shores, patches or even extensive tracts containing a large amount of organic matter may usually be found. At one time these areas may have produced clams. Many times the changes which bring about the adverse conditions have been observed. The great November gale of 1898 converted a large clam bank on the Duxbury (Mass.) flats into a barren waste by throwing upon it great masses of eelgrass and then covering it with a thin layer of sand. Sometimes beds upon which eelgrass grows are covered with sand and the plants die and contaminate the soil. When such changes occur, clams that may be present are smothered, and subsequently it is impossible for others to establish themselves permanently. It may be that these beds eventually become purified and bear clams, but we have no evidence that this is so. If there is a recovery, it is probably very slow, for instances are known of beds which have remained barren for many years after being overwhelmed in this manner by storms.

The amount of lime in the soil has much to do with the character of the shell. "Paper shell" clams are found in beaches of pure sand. Where lime rock is exposed shells become thick and heavy. Lime in the soil also neutralizes humous acids formed by decaying matter.

Without mentioning other cases which have been noticed, it seems probable that the character of the soil itself should be considered carefully in any attempt at clam culture.

THE EFFECT OF EXPOSURE.

In one experiment nearly 20,000 clams were dug, measured, and planted. Before they were put into the beds, it often was necessary to allow them to lie exposed in the heat of July from one to two days. This treatment killed many, and others were so affected that, upon being handled, they contracted their siphons and closed their shells with much indifference. None were planted, however, which were not able to contract completely. In cooler weather, they undoubtedly would have remained in good condition for a much longer time, but it was plainly shown that an exposure of 48 hours to the summer heat

was enough to injure them to such an extent that death quickly followed after planting. Exposure under these conditions for 36 hours led to the death of many, but those which had been out of water for a day, even when exposed directly to the sun for some time, as a rule seemed to be injured very little.

For example, of a large number dug on one low-tide, several were planted 24 hours later, and many survived. The remainder of the same lot was planted under similar conditions after 48 hours of exposure, and almost all died. Their shells showed that they perished before any growth had taken place. None were crowded in planting, and the tide currents were more rapid than on the majority of the beds. In this case the destruction probably should be ascribed not to the contamination of soil and water by the decaying bodies of a few, but rather to the fact that all had been too long exposed before planting.

Several similar cases were noticed, and it seems safe to conclude that during the hot summer months clams for planting can not be exposed safely longer than a day. In culture work this would not often be necessary.

TRANSFER OF CLAMS FROM FRESH TO SALT WATER.

Clams frequently are found in localities where the water is nearly fresh. In such regions diatoms are usually abundant, and clams flourish. Near Falmouth Heights a large, nearly fresh pond supports many clams, and several thousand of these were transplanted directly to the very salt water at Woods Hole. When not too long exposed in the transfer, they seemed to be entirely unaffected by the change, and grew exactly as well as others planted near them which had been taken from the salt water of Buzzards Bay. Though an attempt was made to transfer clams from salt water to this fresh-water pond, the time was too short to prepare a bed properly by removing clams already present in it, and the results are not to be depended upon. The transfer from salt to fresh water probably could be made as well, however, and this possibility of ready transfer is a point of importance, for small clams often may be abundant in waters of one density near favorable planting grounds of another.

In many, if not in the majority, of marine animals a more or less definite amount of salt in the water is necessary for their existence. Even in the case of oysters, which are near relatives of the clam, a slight variation in density determines whether they may live or not. While it is true that the life of individuals may not suddenly be ended when they are placed in water more or less salt than the normal amount, it is also true that reproduction is interfered with, or even entirely prevented by the slightest changes. The American oyster differs from the European species in its requirements and per-

haps is not affected by such slight changes. In the case of the latter, Dean[a] says, "The degree of density of the water is one of the most important factors influencing spawning," and states that a few thousandths of a degree (e. g., 0.002) makes a decided difference. It is of great interest, and of great importance, from an economic point of view, that one of the chief difficulties with which the oyster has to contend in perpetuating itself does not affect the soft clam. A good "set" seems to occur as readily in brackish as in salt water. There seems to be no definite optimum density controlling either the production or the establishment of the young.

SUMMARY.

Conditions of natural growth on beaches and flats:

The soil must be tenacious. On a shifting surface sand grains may pack into the burrow on the withdrawal of the siphons, preventing subsequent extension to the water, and leading to the death of the clam. The more rapid the current the more tenacious must be the surface to prevent erosion.

Surfaces of clam beds are tenacious from several causes.

(*a*) Sand is mixed with cementing substances like fine silt or clay. (*b*) There is frequently a growth of an alga on the surface which prevents any erosion, even in swift currents. (*c*) Clam beaches are sometimes stony or gravelly, and hence are not shifted. (*d*) On extensive flats thatch vegetation prevents a shifting of the surface, and clams frequently are found in great numbers among the plants. (*e*) Eel grass, between tide lines, in the same way, unless growing where the soil contains much organic matter, sometimes prevents erosion and allows clams to establish themselves.

The food of clams consists of diatoms. They are everywhere present, and this condition may be regarded as constant. The amount of food varies in proportion to the rapidity of currents. In large measure the rapidity of the current determines the number of clams that may exist on a given area.

Organic matter in the soil sometimes prevents the existence of clams.

Overcrowding leads either to the rapid extinction of all, or prevents increase in the average size.

Within certain wide limits, the salinity of the water has no apparent effect in determining the existence of clams.

The enemies of adults are few. The gastropod mollusk *Nererita*, however, has been observed below the surface devouring clams.

The conclusion is that on natural beaches and flats the conditions necessary for existence are complex and definite, restricting the dis-

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[a] European Methods of Oyster Culture. U. S. F. C. Bulletin for 1891.

tribution to clearly defined areas. These conditions are constantly changing and shifting the regions where clams may become established.

Conditions controlling the distribution and growth of the young:

The egg develops into a swimming larva which finally settles to the bottom and attaches by means of a byssus. It is some time before the clam is able to burrow. In the meantime it is exposed to many dangers. The young appear scattered on beaches and flats, but at times are segregated in numbers so great that they have scarcely room for lodgment. Such a locality was found at West Falmouth, Mass. These segregations occur below the low-tide mark, and are accounted for by the rapidity of narrow currents where the water bears many swimming embryos. There seems to be no relation between such beds of young and the beds of mature clams on the beaches above them, the latter being recruited only from the few small clams that chance to settle between tide lines and there establish themselves.

On the West Falmouth bed the maximum size on July 10, 1899, was about 11 mm., the minimum about 1 mm., though smaller clams might have been found with a finer sieve than the one used. The larger clams were probably from five to seven weeks old. Several observations on the growth were made from time to time until September. On August 16 the maximum length was about 20 mm. Very small individuals still appeared, though few in number, showing that the breeding season was not yet entirely ended.

Even at the height of the breeding season, early in July, some clams were dying. By August 16 very few remained alive. The explanation of their destruction seems to be (1) lack of sufficient food and (2) the contamination of the water by the decaying bodies of dead clams.

The set varies in different years, sometimes being great, sometimes small.

Conditions determining existence and rapidity of growth in artificial beds:

Experiments were made to determine the rate of growth under many different conditions. The methods are described in detail. Woods Hole harbor was not a favorable locality for showing the possible rapidity of growth. At the head of the harbor, where there was practically no current, series of clams (each of which was measured) from 1⅜ to 2⅝ inches in length were planted. At the end of a year these extremes of the series had increased in volume 556 and 28 per cent, respectively. In another locality where there was some current, clams from 1 inch to 1⅜ inches had increased 1,150 and 711 per cent in volume. In one bed placed where the currents were most rapid, clams exactly 1 inch long were planted, and in a year had increased 1,337 per cent in volume. The conclusion was reached that the rate of growth depends directly upon the amount of food.

Several experiments showed that death from overcrowding was due to lack of food and the spread of contamination from decaying bodies.

Experiments indicated that the character of the bottom had much to do in determining the existence of clams, those soils containing much decaying vegetable matter destroying the shells faster than they could be built up, the active agents being the humous acids formed in the decay of plants.

Exposure out of water in the heat of summer caused death after twenty-four hours.

It was found to be possible to transfer clams from nearly fresh water to very salt water without apparent injury.

THE COMMERCIAL FISHERIES OF THE INTERIOR LAKES AND RIVERS OF NEW YORK AND VERMONT.

BY

JOHN N. COBB,
Agent of the United Stated Fish Commission.

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The first statistical investigation of the commercial fisheries of the interior lakes and rivers of New York and Vermont was made by the writer in 1896. In the fall of 1903 a second canvass was made, when data were gathered showing the condition of the fisheries during the calendar year 1902. With the exception of the Great Lakes and the Hudson, Delaware, and Susquehanna rivers in New York, and the Connecticut River in Vermont, all lakes and rivers in the two States were visited in which it was thought commercial fishing might be carried on. The writer is under great obligations to the Forest, Fish and Game Commission of New York, especially to its secretary, Mr. John D. Whish, and to the Commissioners of Fisheries and Game of Vermont, for many courtesies extended to him.

NEW YORK.

New York is dotted with numerous lakes, many of them—such as Oneida, Champlain, Seneca, and Cayuga—of great extent, while there is a veritable network of rivers, creeks, and canals throughout the State. The principal aim of the authorities has been, as far as possible, to confine the fishing in the interior lakes and streams to sportsmen, who are attracted, not only from all parts of New York, but from other States and even from foreign lands by the excellent fishing afforded in these waters. Such pleasure seekers are usually liberal, and the sums expended by them net a larger profit to the community than would be obtained by the unrestricted use of fishing apparatus on the part of local fishermen. It has been estimated that the sportsmen leave behind them, in the hands of the railroads, hotels, guides, boatmen, etc., several million dollars each year.

Whenever possible without injury to the sport fishing, the State has permitted the use of nets to some extent, principally for the purpose of reducing the abundance of the commoner species of fishes, which, when in excessive numbers, do serious damage to the game fish by devouring spawn and fry. It has been an exceedingly difficult matter to guard waters so extensive, however, and as a result there is much illegal fishing. During 1901 the authorities seized 803 fyke nets, 443

trap nets, 416 gill nets, 76 squat nets, 20 seines, 335 set lines, 7 spears, 16 eel weirs, 8 wire nets, and 2,637 tip-ups. The total number of illegal devices destroyed was 4,761, representing a total money value of $25,820, a sum greater than the whole investment in the legal commercial fisheries of the entire region.

The greatest drawback to the fisheries of many of the lakes and streams is the presence of undesirable species. The alewife in Seneca Lake, the gar in Lake Chautauqua, and the ling in most of the lakes and rivers, are very unpopular residents, and unless their numbers are reduced shortly they will do considerable harm. These fishes appear to be useless, although the ling has been prepared as cod in Buffalo. The German carp is also regarded with some disfavor, but if taken in the winter time and sent alive to New York City would net the shipper a fair price, since it is a very hardy fish and would stand transportation in ice.

Below is a summary of the general conditions and principal features in the fisheries of each lake and river in which commercial fishing was carried on in 1902. A number of other lakes and streams were visited, but as they had no commercial fisheries they are not considered.

BEAR AND CASSADAGA LAKES.

These are small bodies of water close together in Chautauqua County, not far from Lake Chautauqua. During 1902 spearing for muskellunge was permitted in these lakes on Monday and Thursday of each week for five consecutive weeks, beginning on the first Monday in February. The fishing is carried on in almost identically the same manner as in Lake Chautauqua. Hand-line fishing through the ice for bullheads is also practiced on these lakes.

CANANDAIGUA LAKE.

This lake is situated in the counties of Ontario and Yates, a portion forming a part of the boundary line between the two counties. It runs almost due north and south, and is about 15 miles long, while its greatest width is about 2 miles. The lake occupies an eroded valley, and has quite high banks. Its waters discharge through Canandaigua Outlet into Clyde River and thence into Seneca River.

The principal fishing town on this lake is Canandaigua. The only apparatus in use in 1902 consisted of pound nets and set lines, the former owned and operated by the Forest, Fish and Game Commission of the State for the purpose of taking white-fish, which were stripped for fish-cultural purposes and then sold as food. The set lines, which were each about 600 feet long, were operated by the fishermen, and the catch consisted of bullheads, pickerel, suckers, and white-fish, quite a number of the latter being taken in this way.

Early in 1903 the legislature passed a law permitting ice fishing with hand lines and tip-ups, except during the months of March and April, and spearing for all fish but lake trout, black bass, and pike perch, except during April, May, and June. The use of tip-ups and set lines is restricted to a certain section near the head of the lake. As a result of this more liberal law the commercial fisheries will doubtless soon show a considerable expansion.

CAYUGA LAKE.

This is one of the prettiest lakes in the State, lying in a deep eroded valley, the banks for the most part being perpendicular cliffs from 10 to 60 feet high. It extends almost due north and south for about 38 miles, with an average width of 2 miles. Its greatest width is about 3 miles, and its greatest ascertained depth is 390 feet. The outlet from this lake meets Clyde River about 6 miles from the lake, and together these streams form Seneca River.

Commercial fishing in Cayuga Lake is restricted to fyke nets, which are operated from October 1 to March 31, "in that part of the lake which lies north of Canoga Point and within 1,800 feet from the west shore thereof, and in that part of said lake which lies north of the New York Central and Hudson River Railroad bridge across such lake, and within 4 miles of such lake in the waters of all streams and rivers which have an outlet or inlet in such lake north of such bridge." Nearly all of these nets have four hoops, and the mesh is limited by law to not less than 1$\frac{1}{8}$-inch bar. Only common fish, such as bullheads, dogfish, eels, German carp, suckers, and sunfish, can legally be sold, the fishermen being required to return to the water all game fish taken in the nets. The waters swarm with dogfish and German carp, and thousands of pounds of both species are taken, nearly all of which are thrown upon the shores to rot or else are used as fertilizer. As the fyke-net fishing is confined to the foot of the lake, most of the fishermen come from Seneca Falls, Cayuga, Auburn, and Canoga, by far the larger number being from the first-named place.

LAKE CHAMPLAIN.

A considerable portion of the boundary line between New York and Vermont is formed by Lake Champlain, the northern end of which extends for a short distance into Canada. The greater part of the lake, however, is in Vermont, the dividing line in the northern portion lying midway between a chain of islands running down the center and the New York shore. From its head at Whitehall to the border, the lake is about 100 miles long. In the southern part it is less than a mile wide in places; the northern part incloses several large islands, and is nearly 14 miles wide. The greatest ascertained depth is 600 feet. By means of the Richelieu River it discharges into the St. Lawrence.

If both shores are considered, the lake supports more important commercial fisheries than any lake in the United States, the Great Lakes excepted. On the Vermont side seines and gill nets are operated, but New York does not permit the use of nets of any kind, and fishing on that shore is consequently restricted to hand lines, set lines, tip-ups, and spears.

An interesting fishery is that for smelt, locally called "ice fish." This fishery is carried on between Crown Point and Essex, the most important points being Westport and Port Henry. As soon as sufficient ice forms the fishermen carry small huts out to favorable positions on the lake, each hut provided with a small stove and a bench or chair, and having about a third of the bottom floored. The fish are caught with hook and line through a hole cut in the ice. For a time the "ice-fish" caught in this part of the lake, which are exceptionally large (examples 15 and 18 inches long having been captured), were thought by the fishermen to be a different species from the smelt, as the fish taken in other parts of the lake and known as smelts average but about 7 inches in length. At times the catch of "ice fish" is quite heavy, but in 1902 it was small, there being but few fishermen engaged. Nearly all who participate do so because they have no regular occupation, and as last year was a busy and prosperous one in nearly every town along the lake shore there were but few persons out of employment, consequently but few fishermen. In the fishing season at certain hours in the day the buyers visit the huts, gather up the fish caught and bring them to the towns, where they are boxed or barreled for shipment.

Near the foot of the lake considerable fishing for black bass, bullheads, yellow perch, pickerel, and wall-eyed pike is done by means of rod and line, a few set lines are operated for bullheads, and a few spears are used in catching eels.

Lake Champlain is a favorite resort for anglers, and it is the aim of the New York authorities to keep it so. The dumping of refuse from pulp and chemical works into the lake and its tributaries has seriously injured the fisheries during the last few years, but strenuous efforts are now being made to put an end to this practice.

CHAUTAUQUA LAKE.

This lake is in Chautauqua County, in the extreme western part of the State, and is long and narrow, like most of the lakes in this region. It is 22 miles long and from one-fourth of a mile in its narrowest part to 3 miles in width in its widest part, with an average depth of about 20 feet. The head of the lake is about 8 miles distant from Lake Erie, but, unlike all the other lakes of the State, except the small ones, Cassadaga and Bear, which belong to the same system, Chautauqua Lake empties into the Ohio River, through Conewango Creek and Allegheny River.

From a commercial standpoint this lake is one of most important in the State, and principally on account of one fish, the muskellunge. This species is distinct from the muskellunge inhabiting the Great Lakes, but is identical with that occasionally found in the Ohio River basin. Its real home is in this lake, only occasional specimens being found in other waters. New York was the first State to propagate the muskellunge artificially. A hatchery was built in 1890 and the work has continued each year since with considerable success. The State fish commission has introduced the species in other lakes of the State, but in none has it yet attained importance. As a game fish it is held in very high esteem. In summer it is usually taken by trolling with a specially made spoon or a good-sized minnow; a rather short line is used and the boat rowed only fast enough to keep the tackle taut, the spoon being a short distance under water.

Up to and including 1902 fishermen were permitted to spear muskellunge through the ice on Monday and Thursday of each week for five consecutive weeks, beginning on the first Monday in February. During this season the lake presented a busy appearance, as fishermen came from not only the immediate vicinity, but from Pennsylvania and Ohio. For this method of fishing each man is supplied with a "fish coop" and a spear. The "coops" are huts about 4 feet square and from 3½ to 4½ feet in height, with a pair of wide runners underneath, and built perfectly tight in order to exclude every ray of light. Within is a small sheet-iron stove, burning wood or charcoal, to furnish warmth for the fisherman. Opposite the stove is a seat, with only a narrow margin of floor around the inside of the hut for the feet to rest upon. The hole in the bottom of the "coop" is about 3 feet across and, when the "coop" is in place, is immediately above a somewhat larger hole which has been cut in the ice. The spear used in taking the fish has 5 or 7 tines and a short handle, to which is attached a stout cord, and hangs half its length down into the water, secured by a catch on the floor of the "coop." The fisherman sits with one foot on either side of the house and plays a weighted wooden minnow about 6 or 8 feet below the ice. Sometimes he does not have long to wait for a muskellunge to appear, but again there may be no sign of one during the whole day. When a fish does appear it generally approaches the decoy slowly and carefully. The fisherman grasps the spear and quietly poises it directly over the fish, which, as there is no light in the hut, is unable to see its danger. It is his endeavor to plant the spear a little back of the head, thus breaking the backbone and killing the fish almost instantly. He then carefully brings it to the surface, secures it on the spear by means of a gaff hook, lifts it from the water, and throws it through the door of the "coop" upon the ice outside. As soon as the day's fishing is done the "coop" must be removed to the shore to remain until the next legal day for spearing. Owing to the strenuous

objections to this manner of fishing made by sportsmen and others, the legislature of 1903 amended the law so that the practice is now permitted only on Thursday of each week during the month of February.

The gar-pike is an unmitigated nuisance in this lake. Strenuous efforts were made in 1896 and 1897, by securing appropriations of the legislature and through the efforts of private individuals, to get rid of this pest, and the numbers were materially reduced. The fishermen are allowed to spear gar-pike when spearing muskellunge, but as the gar can not be used as food not many are destroyed in this way, although some of the less experienced spearers practice on it first.

Bullheads are also quite abundant. They are taken by means of hand lines fished through the ice, and with set lines during the rest of the year.

Chautauqua Lake leads all other bodies of fresh water in the country in the catch of muskellunge, and, with the exception of the Great Lakes, in the catch of bullheads.

CONESUS LAKE.

This is a medium-sized lake situated wholly in Livingston County, in the western part of the State. The commercial fishing in 1902 was by means of hand lines through the ice, and yellow perch was the only species taken.

LAKE GEORGE.

This beautiful sheet of water, about 36 miles in length, is situated in the eastern part of the State. Like the greater part of Lake Champlain it has high banks, and it discharges into Champlain by means of a short and narrow outlet.

The only commercial fishing permitted is with hand lines, the purpose being to restrict the fishing as much as possible to sportsmen. The species taken in the commercial fishery are black bass, bullheads, lake trout, yellow perch, and pickerel. Large quantities of game fish are unnecessarily destroyed each year by summer residents along the lake shore.

LAKE KEUKA.

Just west of Seneca Lake, into which it empties through a short tributuary, is Lake Keuka, sometimes called Crooked Lake because of its shape. It is about 20 miles long, 2 miles wide, and has an ascertained depth of about 200 feet. Fishing through the ice with tip-ups and hand lines is allowed, except during the months of March and April. Pickerel is the only species taken with the tip-ups. During the summer large quantities of game fish, particularly black bass, lake trout, and pickerel, are caught by means of hook and line, and

sold. From a commercial standpoint this lake is the second most important in the State, being exceeded only by Oneida Lake. So far as game fish alone are concerned, it leads all the other lakes of the State, and, according to the statements of fishermen and others, there are no present indications of decrease in the supply. Penn Yan, at the foot of the lake, and Hammondsport, at the head, are the principal fishing towns.

MILL SITE LAKE.

This is a small lake in Jefferson County, near the town of Redwood. For a number of years a gill-net fishery for cisco, or lake herring, has been carried on here, but it has never amounted to much. Part of the catch each season is salted; the remainder is sold fresh. Nearly all the fish are disposed of in the immediate vicinity.

ONEIDA LAKE.

Oneida is the largest lake wholly within the limits of New York, and is in the central part of the State. It is about 20 miles long, and its greatest width is 6 miles. As it is completely surrounded by railroads, and thus is easily accessible, it is much resorted to by sportsmen.

The principal fishing towns on the shore are Brewerton, at the outlet, Constantia and Cleveland on the north side, and Cicero Center, Bridgeport, and South Bay on the south side of the lake. Trap nets were in use at the time of the statistical canvass made by the U. S. Fish Commission in 1895, the common fish having become so plentiful as to interfere seriously with the game fishing. The use of these nets was prohibited after the 1896 season had passed, however. In 1902 close to and in the outlet 7 seines were operated for black suckers, which come into the lake from Oneida River in countless numbers in the spring, and these operations were considered a great benefit to the other fisheries, as the suckers are said to consume great quantities of the spawn of other species. Set lines, hand lines, and tip-ups were also used.

The tip-up fishery is especially interesting. As in other ice fishing in these lakes, the fishermen have portable huts provided with stoves and benches, and sometimes remain on the lake for weeks. The tip-up is constructed over a hole in the ice, and consists of two sticks about 18 and 24 inches long, 1 inch wide, and a half-inch thick, firmly tied together with twine in the form of a cross. The free end of the line is drawn through a hollow lead sinker by means of a loop of copper wire, the ends of which are bent at right angles for the attachment of the lines, and these, with two hooks on each, are suspended about 18 inches below the sinker. The bait is usually live minnows, and the line is lowered until close to the bottom. The ends of the short cross stick rest on the ice on either side of the hole, the short end of the

long stick being over the center. In order that the weight of the sinker may be just sufficient to make the frame lie flat upon the ice, the line is caught a number of times around the stick. The fish nibbling at the bait causes the end of the cross to tip up, whence the name of the appliance. When the fish seizes the bait the long arm becomes almost perpendicular to the surface of the ice and attracts the attention of the fisherman, who then removes the fish and rebaits the hook. The usual number of tip-ups per hut is about 6 or 8, rigged in as many holes cut in the ice a short distance from the hut and a few feet apart. When the fish are biting well a fisherman with six holes to attend to is a very busy man.

There are a number of slight variations of the tip-up used on the various lakes, but nearly all are built in general as described above. In a few cases a short, supple sapling is stuck into the ice on the side of the hole and the line attached to this. When there is a bite the agitation of the sapling is sufficient to attract the attention of the fisherman. Sometimes a small flag or a sleigh bell is attached to the end of the sapling.

The most important frog fishery of the State is carried on in this lake. In the marshes near the outlet, and for a short distance down the Oneida River, are to be found large quantities of frogs weighing from one-fourth to 1½ and sometimes 3 pounds each. They are usually hunted at night. The fisherman, wearing rubber hip boots, wades in the shallow water, carrying a lighted lantern, a short club, and a bag slung over his shoulder. Making his way in the marsh as noiselessly as possible, he dazzles the frog with the bright light from the lantern, and kills him with a blow of the club.

There has been a considerable falling off in the catch of frogs since 1895. In that year 60,000 pounds, valued at $5,400, were obtained, while in 1902 only 13,100 pounds, valued at $1,220, were taken. The season of 1902 was an exceptionally poor one, however, according to the fishermen, the water being too high for wading, and in 1903 the catch was somewhat larger. The frogs are dressed at Brewerton and the hind legs shipped to all parts of the country, the demand being much in excess of the supply.

During the spring months short set lines are employed in catching bullheads, suckers, and eels.

Oneida Lake is full of the commoner species of fishes, such as ling, suckers, pumpkinseeds, rock bass, etc., which greatly interfere with the game fishing, and it would benefit the sportsmen, with whom this lake is a favorite resort, could some means be devised for decreasing the number of objectionable species. The use of trap nets for a season or two would probably accomplish the purpose.

ONEIDA RIVER.

This river, which is the outlet of Oneida Lake and in conjunction with the Seneca River forms the Oswego River, is about 12 miles long. The only commercial fishing on it is at Caughdenhoy, about 3 miles from the lake. Here are located 14 eel traps, or weirs, which are valued at about $1,400. The manner of building them is as follows: Heavy stakes are driven into the shallow bed of the river until about even with the surface of the water at its medium height, and may be so placed as to form the outline of the letter W extending from shore to shore, the open portion facing upstream. This form permits the construction of two traps. When only one is desired the stakes form a V opening upstream. A wall of planks is built upon the stakes, small openings being left at the two lower tips of the W to be occupied by the traps themselves, which are usually made of lattice-work and are either rectangular or rounded in shape, the lower end of a larger diameter than the upper. From the inner sides of the mouth long laths run back into the trap until they almost meet in the center, leaving only a narrow opening about four inches in diameter between the ends of the laths. During the fall months the eels migrate from Oneida Lake to Lake Ontario, and it is then that the fishermen set their traps. An eel on its way downstream meeting the side wall of the trap swims slowly along it in search of a passage, which it seems to find on reaching the mouth of the trap. Wriggling slowly along the slats to the narrow opening it passes through this and drops down to the bottom of the lattice box, thus securely captured. The traps are visited at certain hours, lifted into a boat, and the eels taken out by means of a small door in the side of the trap.

All the eels caught are smoked, none being sold fresh. As soon as landed the body is split from head to vent and the viscera removed. The head and skin are then taken off, after which the body is immersed in a strong brine for twenty-four hours. On removal from the brine it is washed with stiff brushes to remove the slime and surplus salt, then strung on iron or steel rods and hung in a smokehouse. Moisture is removed by means of a hot fire of kindlings, then the cooking is done by a fire of corncobs, great care being exercised at this stage lest the heat become so great as to curl the fish out of shape. After the cooking the fire is partially smothered with sawdust, making a dense smoke, and the fish is soon cured. The total length of time in the smokehouse is about four hours. Smoked eels can be kept a shorter time than almost any fish so prepared, from five to twelve days being about the limit; hence they must be marketed as soon as possible after being removed from the smokehouse. The product is sold in Syracuse and vicinity. The smokers are unable to expand

their business, as they find it increasingly difficult each year to supply the local demand. The season of 1902 was very poor, and 1903 was even worse, owing to the excessively high water which prevailed most of the time, allowing the eels to escape over the sides of the traps.

Several years ago the fishermen came to an agreement among themselves to the effect that the whole business should be carried on in one smokehouse and with but one selling agent to dispose of the whole product. This has been found much more economical than the former method, with each man curing and selling his own catch.

The eel fishery has been prosecuted for many years, and it has been well said that "Caughdenhoy was built on eels," as that is, and always has been, the principal business of the village. The industry is now in danger of destruction, however, as the farmers living on the river between the village and Oneida Lake and for several miles along the shores of the lake threaten to enter suit for damages to their lands from overflows, which, they claim, are caused by these eel traps. As the traps are rarely more than 15 inches in height, it does not seem probable that they could cause the water to overflow land several miles upstream.

ONONDAGA LAKE.

In 1894 and 1895 there was a considerable gill-net fishery for whitefish in this lake, but this ceased soon after that time, owing to the almost complete disappearance of the fish. The fishermen ascribe this disappearance to the pollution of the water by refuse from several large chemical plants on the shores of the lake. The city of Syracuse, which abuts upon the western shore, also runs its sewage into the lake. No commercial fishing is now carried on. There are said to be large quantities of German carp and ling in the lake.

OTSEGO LAKE.

This lake, the source of the Susquehanna River, is in Otsego County, in the eastern part of the State, and has a length of about 9 miles and an average width of 1½ miles. It is quite popular as a summer resort, Cooperstown being the principal town on its shores. For some years seines were used for catching whitefish, locally known as Otsego bass, but in 1901 the legislature closed the lake to all manner of commercial fishing, except with hook and line, until May 1, 1906. As a result the commercial fishing is at present of minor importance.

OWASCO LAKE.

Lying about midway between Cayuga and Skaneateles lakes, with a length of 10 or 11 miles and a width of more than a mile, Owasco Lake empties into the Seneca River through Owasco Outlet. It is wholly within Cayuga County. The only commercial fishing is done by means of tip-ups in the winter time at the upper end of the lake. Bullheads, eels, yellow perch, and sunfish are the species taken.

SENECA LAKE.

Next to Oneida this is the largest lake wholly within the borders of the State. It extends almost directly north and south, is about 36 miles long, from 1 to 4 miles wide, and with a maximum depth of 500 to 600 feet, occupying an eroded valley flanked by bold hills, and discharging into Cayuga Lake by means of a short outlet. It is unique among New York lakes in that the surface is never entirely frozen.

Gill nets, spears, and a few fyke nets and hand lines are used in the commercial fisheries. The gill nets, which average in length about 110 yards each, with bar mesh of not less than 2 inches, are used principally for lake trout and are operated between May 1 and October 15 of each year. The use of spears is permitted from April 15 to June 15, inclusive. The principal fishing towns are Himrods, Dundee, Hector, North Hector, Caywood, Starkey, Dresden, and Geneva.

The sportsmen complain that the lake trout, which are very numerous, will not take the hook. It is possible that this may be owing to the large numbers of alewives (*Pomolobus pseudoharengus*) in the lake, upon which the trout feed. The fishermen believe quite generally that this species was introduced into Seneca Lake by Seth Green, about 1872, but this is not the case, the fish having been known there a number of years previous. It has been a source of great trouble, owing to the annual mortality to which it is subject here as in Lake Ontario. During the summer large numbers die and, decaying on the shores, cause much annoyance to the inhabitants, while doubtless many of the fish sink and pollute the waters. The mortality has not been as heavy as usual during the last two summers.

German carp are becoming quite plentiful at the head of the lake, but very little use is made of them.

SENECA RIVER.

This is the outlet directly or by means of short streams of most of the lakes in central New York. It discharges into Lake Ontario through the Oswego River, the latter being formed by the junction of Seneca and Oneida rivers. There is an immense amount of illegal fishing practiced in this river, despite the strenuous efforts of the State authorities to suppress it. Owing to the length and general inaccessibility of the stream, it is a difficult matter to guard it. Almost the only commercial fishing concerning which reliable data could be obtained was that with hand lines and traps for fishes and with spears for frogs. The principal fishing towns are Weedsport and Savannah. Considerable complaint is made by the fishermen of the large numbers of ling and German carp in the river. Black suckers also are very numerous.

SKANEATELES LAKE.

This lake lies almost midway between Oneida and Cayuga, and, like most of the other lakes of the State, is long and narrow, being about 15 miles in length and 1½ miles in width at the widest part, with a depth of 320 feet. Through a short outlet it discharges into Seneca River. Its commercial fisheries are insignificant, hand and set lines being the only apparatus permitted. Lake trout is the principal fish caught with the hand lines, bullheads and suckers the only species taken on the set lines.

STATISTICS OF THE INTERIOR FISHERIES OF NEW YORK.

The following tables show, by lakes and rivers, the condition of the interior fisheries of New York in 1902. In 1895 the number of fishermen was 543, in 1902 it was 804, a gain of 261. Seneca Lake shows the greatest increase. The total investment in 1895 amounted to \$19,745; in 1902 to \$25,291, a gain of \$5,546. Seneca Lake leads in total investment, with Oneida and Champlain lakes second and third, respectively. In 1895 the total catch was 754,730 pounds, valued at \$60,068, while in 1902 it amounted to 1,530,918 pounds, valued at \$87,897, a gain of 776,188 pounds and \$27,811. Oneida Lake leads in the quantity secured, and the value of the catch is exceeded only in Chautauqua Lake, by a very narrow margin. Keuka Lake is third. The interior waters of New York produce more muskellunge and smelt than the waters of any other State in the Union, and they lead all others, except the Great Lakes, in the catch of bullheads, pickerel, wall-eyed pike (except Minnesota), yellow perch, and suckers.

Table showing, by waters, the apparatus used and species taken in the interior fisheries of New York.

Items.	Bear Lake.		Canandaigua Lake.		Cassadaga Lake.		Cayuga Lake.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Boats			10	\$160			47	\$720
Apparatus:								
Pound nets			7	560				
Fyke nets							211	1,055
Set lines ....yds.			3,200	80				
Hand lines		\$3				\$4		
Spears	4	10			8	20		
Shore property		18		275		40		82
Total		31		1,075		64		1,857
CATCH.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bullheads and catfish	7,500	\$375	6,300	\$378	10,000	\$500	36,918	\$2,198
Dog-fish							300	6
Eels, fresh							2,190	110
German carp							1,474	18
Muskellunge	2,700	405			4,300	645		
Pickerel			920	92				
Suckers			1,900	114			4,764	187
Sun-fish							225	23
White-fish			4,817	359				
Total	10,200	780	13,937	943	14,300	1,145	45,871	2,542

Table showing, by waters, the apparatus used and species taken in the interior fisheries of New York—Continued.

Items.	Lake Champlain.*		Chautauqua Lake.		Conesus Lake.		Lake George.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Boats	31	$830	40	$1,200			14	$640
Apparatus:								
Set lines ... yds.	667	20	6,000	150				
Hand lines		131		240		$2		39
Tip-ups	550	112						
Spears	3	3	65	144				
Shore property		1,923		275				
Total		3,019		2,009		2		679
CATCH.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black bass	2,775	$227	12,800	$1,540			6,000	$766
Bullheads and cat-fish	33,400	1,328	96,100	4,805			12,000	825
Eels, fresh	1,900	152						
Lake trout							2,100	402
Muskellunge	250	30	85,400	12,810				
Perch, yellow	32,000	2,102			8,000	$1,000	3,250	360
Pickerel	45,810	3,447					1,800	270
Pike, wall-eyed	7,540	779						
Rock bass	1,000	60						
Smelt	17,600	2,120						
Frogs			5,200	156				
Total	142,275	10,245	199,500	19,311	8,000	1,000	25,150	2,623

Items.	Keuka Lake.		Mill Site Lake.		Oneida Lake.		Otsego Lake.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Boats	57	$2,280	4	$115	37	$970	10	$300
Apparatus:								
Seines					7	210		
Gill nets			19	275				
Set lines ... yds.					12,000	300		
Hand lines		300				10		70
Tip-ups	600	60			740	74		
Shore property		330		155		1,480		80
Total		2,970		545		3,044		450
CATCH.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black bass	10,000	$1,000			500	$50		
Bullheads and cat-fish	25,500	1,275			30,550	1,222	3,800	$456
Eels, fresh					5,500	275		
Lake herring, fresh			9,200	$138				
Lake herring, salted			10,500	447				
Lake trout	47,770	5,732					980	147
Perch, yellow	48,750	3,900			13,400	670	700	70
Pickerel	32,400	3,240			18,288	1,463	1,200	120
Pike, wall-eyed					23,755	1,901		
Rock bass							150	15
Suckers	1,000	80			616,900	12,507		
Sun-fish	2,000	160						
White-fish							500	75
Frogs					13,100	1,220		
Total	167,420	15,387	19,700	585	721,993	19,308	7,330	883

*Includes only the fisheries on the New York side of the lake; those on the Vermont side will be found under Vermont.

Table showing, by waters, the apparatus used and species taken in the interior fisheries of New York—Continued.

Items.	Owasco Lake.		Seneca Lake.		Skaneateles Lake.	
	Number.	Value.	Number.	Value.	Number.	Value.
Boats	....	....	125	$4,840	8	$240
Apparatus:						
Gill nets	....	....	93	930	....	....
Fyke nets	....	....	2	12	....	....
Set lines ....yds	....	....	....	....	1,600	40
Hand lines	....	....	....	6	....	25
Tip-ups	140	$14	....	....	....	....
Spears	....	....	44	110	....	....
Shore property	....	105	....	882	....	10
Total	....	119	....	6,780	....	315
CATCH.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black bass	....	....	929	$142	800	$120
Bullheads and cat-fish	6,000	$300	9,710	486	6,300	315
Eels, fresh	400	32	2,075	200	....	....
German carp	....	....	1,410	71	....	....
Lake trout	....	....	22,017	3,054	2,300	345
Perch, yellow	2,000	160	42,448	3,415	750	60
Rock bass	....	....	650	49	....	....
Suckers	....	....	10,178	784	1,600	80
Sun-fish	290	25	1,675	134	....	....
White-fish	....	....	540	74	....	....
Frogs	....	....	600	120	....	....
Total	8,690	517	92,232	8,529	11,750	920

Items.	Oneida River.		Seneca River.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Boats	2	$20	21	$420	406	$12,735
Apparatus:						
Seines	....	....	....	....	7	210
Gill nets	....	....	....	....	112	1,205
Pound nets	....	....	....	....	7	560
Fyke nets	....	....	....	....	213	1,067
Set lines ....yds	....	....	....	....	23,467	590
Hand lines	....	....	....	53	....	883
Tip-ups	....	....	....	....	2,030	260
Spears	....	....	8	4	132	291
Eel traps	14	1,400	1	80	15	1,480
Shore property	....	250	....	105	....	6,010
Total	....	1,670	....	662	....	25,291
CATCH.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black bass	....	....	3,200	$384	37,004	$4,229
Bullheads and cat-fish	....	....	16,100	805	300,178	15,268
Dog-fish	....	....	....	....	300	6
Eels, fresh	....	....	1,300	144	13,365	913
Eels, smoked	11,260	$900	....	....	11,260	900
German carp	....	....	410	16	3,294	105
Lake herring, fresh	....	....	....	....	9,200	138
Lake herring, salted	....	....	....	....	10,500	447
Lake trout	....	....	....	....	75,167	9,680
Muskellunge	....	....	....	....	92,650	13,890
Perch, yellow	....	....	....	....	151,298	11,737
Pickerel	....	....	2,000	200	102,418	8,832
Pike, wall-eyed	....	....	4,500	540	35,795	3,220
Rock bass	....	....	....	....	1,800	124
Smelt	....	....	....	....	17,600	2,120
Suckers	....	....	1,000	50	637,342	13,802
Sun-fish	....	....	....	....	4,190	342
White-fish	....	....	....	....	5,857	508
Frogs	....	....	2,800	140	21,700	1,636
Total	11,260	900	31,310	2,279	1,530,918	87,897

While the seine catch is the greatest in quantity, it is exceeded in value by that with hand lines. The tip-up catch is third. The only species taken in seines was suckers, while with gill nets the leading species were lake trout, yellow perch, and lake herring. Fyke nets were in use in but two lakes, and the catch in the aggregate does not amount to much, the bullhead being the principal species captured. With set lines bullheads and suckers, and with tip-ups pickerel, bullheads, wall-eyed pike, and yellow perch were the chief species taken. Muskellunge and yellow perch predominate in the spear catch.

Table showing by waters, species, and apparatus the yield of the interior fisheries of New York in 1902.

Apparatus and species.	Bear Lake.		Canandaigua Lake.		Cassadaga Lake.		Cayuga Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Fyke nets:								
Bullheads and catfish	....	....	....	....	....	....	36,918	$2,198
Dog-fish	....	....	....	....	....	....	300	6
Eels	....	....	....	....	....	....	2,190	110
German carp	....	....	....	....	....	....	1,474	18
Suckers	....	....	....	....	....	....	4,764	187
Sun-fish	....	....	....	....	....	....	225	23
Total	....	....	....	....	....	....	45,871	2,542
Pound nets:								
White-fish	....	....	*2,317	46	....	....	....	....
Hand lines:								
Bullheads and catfish	7,500	$375	....	....	10,000	$500	....	....
Total	7,500	375	....	....	10,000	500	....	....
Set lines:								
Bullheads and cat-fish	....	....	6,300	378	....	....	....	....
Pickerel	....	....	920	92	....	....	....	....
Suckers	....	....	1,900	114	....	....	....	....
White-fish	....	....	2,500	313	....	....	....	....
Total	....	....	11,620	897	....	....	....	....
Spears:								
Muskellunge	2,700	405	....	....	4,300	645	....	....
Total	2,700	405	....	....	4,300	645	....	....
Grand total	10,200	780	13,937	943	14,300	1,145	45,871	2,542

Apparatus and species.	Champlain Lake.		Chautauqua Lake.		Conesus Lake.		George Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Hand lines:								
Black bass	2,775	$227	12,800	$1,540	....	....	6,000	$766
Bullheads and cat-fish	12,600	378	73,000	3,650	....	....	12,000	825
Lake trout	....	....	....	....	....	....	2,100	402
Muskellunge	250	30	48,400	7,260	....	....	....	....
Perch, yellow	11,600	740	....	....	8,000	1,000	3,250	360
Pickerel	9,700	792	....	....	....	....	1,800	270
Pike, wall-eyed	4,320	390	....	....	....	....	....	....
Rock bass	1,000	60	....	....	....	....	....	....
Smelt	17,600	2,120	....	....	....	....	....	....
Total	59,845	4,737	134,200	12,450	8,000	1,000	25,150	2,623
Set lines:								
Bullheads and cat-fish	6,000	210	23,100	1,155	....	....	....	....
Total	6,000	210	23,100	1,155	....	....	....	....

*Had been stripped of spawn and milt before being sold.

Table showing by waters, species, and apparatus the yield of the interior fisheries of New York in 1902—Continued.

Apparatus and species.	Champlain Lake.		Chautauqua Lake.		Conesus Lake.		George Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Tip-ups:								
Bullheads and cat-fish	14,800	$740						
Perch, yellow	20,400	1,362						
Pickerel	36,110	2,655						
Pike, wall-eyed	3,220	389						
Total	74,530	5,146						
Spears:								
Eels	1,900	152						
Muskellunge			37,000	$5,550				
Frogs			5,200	156				
Total	1,900	152	42,200	5,706				
Grand total	142,275	10,245	199,500	19,311	8,000	$1,000	25,150	$2,623

Apparatus and species.	Keuka Lake.		Mill Site Lake.		Oneida Lake.		Otsego Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:								
Suckers					600,000	$12,000		
Gill nets:								
Lake herring, fresh			9,200	$138				
Lake herring, salted			10,500	447				
Total			19,700	585				
Hand lines:								
Black bass	10,000	$1,000			500	50		
Bullheads and cat-fish	25,500	1,275			1,750	70	3,800	$156
Lake trout	47,770	5,732					980	147
Perch, yellow	48,750	3,900			1,500	75	700	70
Pickerel	26,400	2,640			800	64	1,200	120
Pike, wall-eyed					1,600	128		
Rock bass							150	15
Suckers	1,000	80						
Sun-fish	2,000	160						
White-fish							500	75
Total	161,420	14,787			6,150	387	7,330	883
Set lines:								
Bullheads and cat-fish					28,800	1,152		
Eels					5,500	275		
Suckers					16,900	507		
Total					51,200	1,934		
Tip-ups:								
Perch, yellow					11,900	595		
Pickerel	6,000	600			17,488	1,399		
Pike, wall-eyed					22,155	1,773		
Total	6,000	600			51,543	3,767		
Miscellaneous:								
Frogs					13,100	1,220		
Grand total	167,420	15,387	19,700	585	721,993	19,308	7,330	883

Apparatus and species.	Owasco Lake.		Seneca Lake.		Skaneateles Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gill nets:						
Black bass			929	$142		
Lake trout			17,067	2,184		
Perch, yellow			16,848	1,367		
Suckers			5,268	423		
White-fish			540	74		
Total			40,652	4,190		

Table showing by waters, species, and apparatus the yield of the interior fisheries of New York in 1902—Continued.

Apparatus and species.	Owasco Lake.		Seneca Lake.		Skaneateles Lake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Fyke nets:						
Bullheads and cat-fish			1,300	$65		
Hand lines:						
Black bass					800	$120
Bullheads and cat-fish			7,800	390		
Lake trout					2,300	315
Perch, yellow					750	60
Total			7,800	390	3,850	525
Set lines:						
Bullheads and cat-fish					6,300	315
Suckers					1,600	80
Total					7,900	395
Tip-ups:						
Bullheads and cat-fish	6,000	$300				
Eels	400	32				
Perch, yellow	2,000	160				
Sun-fish	290	25				
Total	8,690	517				
Spears:						
Bullheads and cat-fish			610	31		
Eels			2,075	200		
German carp			1,410	71		
Lake trout			4,950	870		
Perch, yellow			25,600	2,048		
Rock bass			650	49		
Suckers			4,910	361		
Sun-fish			1,675	134		
Total			41,880	3,764		
Miscellaneous:						
Frogs			600	120		
Grand total	8,690	517	91,532	8,529	11,750	920

Apparatus and species.	Oneida River.		Seneca River.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:						
Suckers					600,000	$12,000
Gill nets:						
Black bass					929	142
Lake herring, fresh					9,200	138
Lake herring, salted					10,500	447
Lake trout					17,067	2,184
Perch, yellow					16,848	1,367
Suckers					5,268	423
White-fish					540	74
Total					60,352	4,775
Fyke nets:						
Bullheads and cat-fish					38,218	2,263
Dog-fish					300	6
Eels					2,190	110
German carp					1,474	18
Suckers					4,764	187
Sun-fish					225	23
Total					47,171	2,607
Pound nets:						
White-fish					2,317	46

Table showing by waters, species, and apparatus the yield of the interior fisheries of New York in 1902—Continued.

Apparatus and species.	Oneida River.		Seneca River.		Total.	
	Pounds	Value.	Pounds.	Value.	Pounds.	Value.
Hand lines:						
Black bass			3,200	$384	36,075	$4,087
Bullheads and cat-fish			16,100	805	170,050	8,724
Eels			300	24	300	24
German carp			410	16	410	16
Lake trout					53,150	6,626
Muskellunge					48,650	7,290
Perch, yellow					74,550	6,205
Pickerel			2,000	200	41,900	4,086
Pike, wall-eyed			4,500	540	10,420	1,058
Rock bass					1,150	75
Smelt					17,600	2,120
Suckers			1,000	50	2,000	130
Sun-fish					2,000	160
White-fish					500	75
Total			27,510	2,019	458,755	40,676
Set lines:						
Bullheads and cat-fish					70,500	3,210
Eels					5,500	275
Pickerel					920	92
Suckers					20,400	701
White-fish					2,500	313
Total					99,820	4,491
Tip-ups:						
Bullheads and cat-fish					20,800	1,040
Eels					400	32
Perch, yellow					34,300	2,117
Pickerel					59,598	4,654
Pike, wall-eyed					25,375	2,162
Sun-fish					290	25
Total					140,763	10,030
Spears:						
Bullheads and cat-fish					610	31
Eels					3,975	352
German carp					1,410	71
Lake trout					4,950	870
Muskellunge					44,000	6,600
Perch, yellow					25,600	2,048
Rock bass					650	49
Suckers					4,910	361
Sun-fish					1,675	134
Frogs			2,800	140	8,000	296
Total			2,800	140	95,780	10,812
Eel traps:						
Eels, fresh			1,000	120	1,000	120
Eels, smoked	11,260	$900			11,260	900
Total	11,260	900	1,000	120	12,260	1,020
Miscellaneous:						
Frogs					13,700	1,340
Grand total	11,260	900	31,310	2,279	1,530,918	87,897

Table showing fishermen employed on inland waters of New York.

Body of water.	Number.	Body of water.	Number.
Lakes:		Lakes—Continued.	
Bear	6	Oneida	77
Canandaigua	14	Otsego	26
Cassadaga	10	Owasco	7
Cayuga	49	Seneca	242
Champlain	175	Skaneateles	8
Chautauqua	65	Rivers:	
Conesus	12	Oneida	4
George	13	Seneca	21
Keuka	67		
Mill Site	8	Total	804

VERMONT.

With the exception of Lake Champlain, the commercial fisheries of the lakes and streams of Vermont are insignificant. In 1902 there were five gill nets used in taking white-fish in Lake Bomoseen, two in Lake St. Catherine, one in Lake Memphremagog, and one in Lake Hortonia. In Lake Bomoseen 3,462 white-fish were taken in these gill nets, in Lake St. Catherine 534, in Lake Memphremagog 105, and in Lake Hortonia 165. A very few perch, pickerel, and sun-fish were also taken. Nearly all the fish captured were used or given away by the fishermen, and the fishery, therefore, can hardly be classed as commercial. As the catch is so small, the State fish commissioners have recommended that the granting of licenses to fish in these waters be discontinued.

In Lake Champlain entirely different conditions prevail. For some years the seine fisheries on the Vermont side of the lake have been numerous and exceedingly important for such a body of water, especially in Missisquoi Bay, at the foot of the lake. There have been many attempts to stop this form of fishing, which is exceedingly destructive to some of the most valuable species in the lake, more particularly the wall-eyed pike, which forms nearly half of the catch, and white-fish and pickerel, but it seems impossible to do this so long as Canada permits her fishermen to haul seines in that part of the bay which lies within her borders. The seines are operated in the spring principally for wall-eyed pike; in the fall, mainly for white-fish, which are locally known as "shad."

A few gill nets were operated for sturgeon near the foot of the lake in 1902 and met with fair success. A hand-line fishery through the ice for smelt was carried on from Burlington and vicinity and a few tip-ups and spears were also employed. Quite a number of set lines were used, but the fish taken thus were consumed almost entirely by the fishermen themselves.

As compared with the figures for 1895 the fisheries show a most gratifying increase so far as apparatus and shore and accessory property are concerned, while the total catch more than doubled and the value more than quintupled in the same time. The number of fishermen employed was 145, using 69 boats, valued at $2,795, and apparatus as follows: 57 haul seines, 10,594 yards in length, valued at $2,720; 30 gill nets, 2,475 yards in length, valued at $180; 85 tip-ups, $17; hand lines, $12; and spears, 5 in number, worth $3. With shore property valued at $3,690, the total investment in these fisheries was $9,417.

In 1895 the catch amounted to 208,139 pounds, valued at $7,160, while in 1902 it was 528,682 pounds, which sold for $37,669, a gain of 320,543 pounds and $30,509. With the exception of lakes Erie and

Huron, Lake Champlain leads all other bodies of fresh water in the United States in the catch of wall-eyed pike and pickerel.

The table below shows the extent of the commercial fisheries on the Vermont side of the lake in 1902:

Table showing by apparatus and species the yield of the fisheries on the Vermont side of Lake Champlain in 1902.

Species.	Haul seines.		Tip-ups.		Gill nets.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bullheads and cat-fish	54,920	$1,679	4,700	$118		
Eels	4,100	206				
Lake herring	660	33				
Perch, yellow	43,917	2,575				
Pickerel	48,111	3,856	3,600	288		
Pike, wall-eyed	203,836	16,319	7,100	596		
Rock bass	674	40				
Sturgeon	1,460	73			14,130	$1,978
Caviar					1,000	750
Suckers	37,375	1,854				
Sun-fish	15,308	767				
White-fish	80,191	5,777				
Total	490,552	33,179	15,400	1,002	15,130	2,728

Species.	Hand lines.		Spears.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bullheads and cat-fish					59,620	$1,797
Eels					4,100	206
Lake herring					660	33
Perch, yellow					43,917	2,575
Pickerel					51,711	4,144
Pike, wall-eyed					210,936	16,915
Rock bass					674	40
Smelt	6,000	$600			6,000	600
Sturgeon					15,590	2,051
Caviar					1,000	750
Suckers					37,375	1,854
Sun-fish					15,308	767
White-fish					80,191	5,777
Frogs			1,600	$160	1,600	160
Total	6,000	600	1,600	160	528,682	37,669

INVESTIGATIONS FOR THE PROMOTION OF THE OYSTER INDUSTRY OF NORTH CAROLINA.

BY

CASWELL GRAVE, Ph. D.,

Director of Fisheries Laboratory, Beaufort, N. C

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INVESTIGATIONS FOR THE PROMOTION OF THE OYSTER INDUSTRY OF NORTH CAROLINA.

By Caswell Grave, Ph. D.,
Director of Fisheries Laboratory, Beaufort, N. C.

INTRODUCTION.

The following report is based upon a study of the physical and biological conditions of natural and planted oyster beds in various localities in North Carolina, and contains a record of experiments in oyster culture conducted in Newport and North rivers near Beaufort. The physical and biological investigations, which were conducted from the U. S. Fish Commission steamer *Fish Hawk*, were begun in October, 1899, and, after an interruption extending from the end of March to the first of November, were completed in December, 1900. The experimental work covered a period of three years, beginning in April, 1900.

The objects of the work of the *Fish Hawk* were: (1) To ascertain the present extent and condition of the natural oyster beds in certain sections, for the purpose of comparison with determinations by Winslow on the same ground in 1886–1888; (2) to study comparatively the biological conditions of a number of good natural oyster beds and typical planted areas, with the object of determining the natural cause, if such exists, for the failure of the planted beds; (3) to study the physical and biological characters of the bottom and water of various localities for comparison with the conditions prevailing on good oyster-producing localities of the North, and (4) to collect statistics bearing upon the value and extent of the oyster fishery of the State in the past and at the present time.

Boatswain James A. Smith, U. S. Navy, commanding the *Fish Hawk*, assisted by Mr. W. F. Hill, of the U. S. Fish Commission, conducted the hydrographic survey of the sections investigated and made accurate charts of each, showing the natural and planted oyster beds, the character of the bottom, the depth of the water, the direction and velocity of the currents, and such other conditions as may, directly or indirectly, affect the growth of oysters.

Data showing the extent of the oyster industry in all its branches were collected by Mr. C. H. Stevenson.

In the investigation of the biological and physical conditions of the oysters and oyster beds, the following factors were considered: (1) The organisms that make up the food of the North Carolina oysters; (2) the source of this supply and its richness in different localities and at different seasons of the year; (3) the effect of bottoms of different character upon the growth of oysters; (4) the effect of water of different densities upon the growth and condition of oysters; (5) the enemies and diseases of North Carolina oysters; (6) the animals and plants that are found living with the oysters on natural and planted beds.

The experiments were designed (1) to determine whether it is possible to develop a profitable industry in oyster culture in North Carolina on the grounds available for planting purposes, and (2) in case no insurmountable obstacles to the growth of marketable oysters on these grounds should be found to exist, to develop simple methods of oyster culture by which the failures hitherto attending attempts to grow oysters on planted beds might be avoided in future operations.

Owing to additional duties, it became necessary at the beginning of the second season for me to have an assistant in the experimental work, and Mr. O. C. Glaser was employed. The experiments were at first conducted jointly, but during the third season Mr. Glaser was alone in that phase of the investigations, following the original plans, however, and using the methods already adopted. He also began some further experiments on the growth of oysters, a description of which is included in this report (pages 329–341).

The survey of the oyster grounds and the experiments in oyster planting have been carried on jointly by the United States Fish Commission and the North Carolina Geological Survey, the greater part of the expense connected with the former being paid by the Fish Commission, the Geological Survey paying the greater part of the cost of the experiments. To Prof. J. A. Holmes, State geologist of North Carolina, is due much of the credit for any advantage to the oyster industry of North Carolina that may result from this investigation. It was at his suggestion that the United States Fish Commission began the work, and his plans have been followed by those in charge of the various lines of investigation. Prof. W. K. Brooks and Prof. H. V. Wilson were also consulted in regard to the biological work, and it is a pleasure to acknowledge the helpfulness of their advice and encouragement. Mr. Hollister Potter, of Beaufort, generously placed at our disposal the oyster shells needed for the planting experiments, and I take this opportunity to thank him publicly for the many evidences of the sympathetic and intelligent interest he has taken in the work from its beginning. Thanks are also due to Capt. J. A. Smith, the other

officers, and the crew of the *Fish Hawk*, from whom I received many favors while stationed on the vessel.

In the preparation of this report free use has been made of the investigations of Captain Smith and Mr. Stevenson; and the chapters on the anatomy and development of the oyster, at the request of Professor Holmes in the special interest of the North Carolina oystermen, have been reprinted from the United States Fish Commission Report for 1897.

METHODS.

The exact conditions which are most favorable to the growth of oysters and which determine their quality are not sufficiently well known to make it possible, at present, to predict the results of oyster planting in an untried locality. It is altogether possible, too, that sufficient data may never be compiled from which such predictions can be made, but the use of accurate methods of observing and recording certain of the conditions under which the oysters of different localities live is a step in this direction which should be continued. The published observations on the density of the water on oyster beds in almost every oyster-producing region along the Atlantic coast are such as to be of great value to prospective oyster planters. Other factors, such as the general character of the bottom, depth of water, and velocity of currents, have also in a few instances been well described, but the terms used are usually indefinite, and nothing is given concerning the methods employed. In order to have real value in comparing the different localities, all observations on the same condition or set of conditions should be made according to uniform and accurate methods. In the work of the present survey, therefore, considerable attention was paid to this subject, and whenever possible methods already in general use were adopted.

The description, which follows, of the methods used in the work of the biologist does not include methods of oyster planting, as they are best considered in the chapter dealing with the experiments.

The salinity or specific gravity of the water over the oyster beds was determined in the usual way, Hilgard's ocean salinometer being used. This apparatus consists of a copper cup for holding the sample of water, and a series of three sealed glass floats, each float a cylindrical bulb with a slender stem, the bottom weighted with a small amount of shot and the stem containing a graduated scale, which in the first float reads downward from 1.000 to 1.011, in the second from 1.010 to 1.021, and in the third from 1.020 to 1.031. The weight in the first is just sufficient to cause the float to sink in fresh water to the top of the scale, marked 1.000, the specific gravity of fresh water; as salts are dissolved in the water the specific gravity is increased, in pure sea water reaching 1.023–1.027. Float No. 1 is therefore used for determining the specific gravity of brackish water, No. 3 in ascertain-

ing the specific gravity of ordinary sea water, and No. 2 for water between these grades.

The specific gravity varies to some extent with the temperature, being less when the water is warm than when cold. Thus in work requiring very great accuracy it is necessary to standardize all specific gravity observations—that is, to calculate the error in each case due to temperature with reference to an adopted standard. For all practical purposes, however, this inaccuracy is not great enough to materially modify results, and may be disregarded.

The water over the oyster beds was examined frequently at different stages of the tide and at different seasons of the year. Readings from the salinometers were regularly taken and recorded, and at the end of each month a general average was made. These averages appear in this report in the food tables.

The apparatus for determining the velocity and direction of the currents which flow over the oyster beds was designed by Prof. J. A. Holmes and consists of a cylindrical "drag" suspended by a wire from a small floating buoy. The distance between the buoy and the drag is regulated according to the depth of the water, the aim being to have the drag suspended in the swiftest part of the current. To the buoy or float is attached a long line, wound upon a reel, on which are tied at intervals of 50 feet small pieces of colored cloth. In determining the velocity of the current in a certain locality by means of this apparatus, a launch or other boat was first anchored in the channel and the drag and float lowered from the stern. As soon as the drag filled with water and sank, the line was allowed to pay out until the first mark appeared; it was then held until the timekeeper gave the signal to set it free. The time required for each of the marks on the line to be carried past a mark on the stern of the boat was noted, and from these observed intervals the rate of the current per mile was calculated. Numerous observations and calculations of this kind were made in each locality, and an average was computed. These are shown on the charts and in the text.

The character of the bottom in each locality was carefully examined, first by means of a sounding rod, and then from a sample collected by using a short piece of sharpened iron piping welded to a long iron rod. This being thrust into the bottom, unless the latter were composed of pure sand or shells, the instrument came up filled. The contents were examined in the laboratory under the microscope when desirable.

The constituents of the food of oysters have been repeatedly determined, but the cases are few in which attempts have been made to ascertain the amount of each constituent and its source. The interesting qualitative examinations made by Lotsy[a] gave a general idea of

[a] J. P. Lotsy.—The Food of the Oyster, Clam, and Ribbed Mussel. U. S. F. C. Report 1893, pp. 375–386.

the food of Chesapeake oysters, but they do not show the food value of the water. In his report on the oyster beds of Louisiana, Moore[a] gives the actual amount of food found in a given quantity of the water taken over the best oyster beds, the calculations based on examinations with the microscope and the Rafter cell. A very similar method was employed in my work, but before describing it the method used by Bashford Dean[b] in dealing with the same problem in the oyster survey of South Carolina waters may appropriately be discussed. Dean used a chemical test in determining the food value of the water, the amount of albuminoid ammonia being taken as representing the amount of available oyster food, or at least supplying data from which the relative value of different localities for oyster culture might be compared. In obtaining a specimen of water for analysis he proceeded as follows: Two liters of water was collected 1 foot from the bottom over the oyster grounds, brought to the laboratory, and after being vigorously agitated was allowed to stand for a few minutes so that the sediment might settle. A sufficient quantity of water for analysis was then taken from the middle of the jar. It is here supposed, as is shown by the following quotation, that the organisms which constitute the food of the oysters will remain suspended, while the organic impurities will have settled: "The specimen represents the average prevalence of oyster food in the given locality, and, if properly collected, it may be proven by the microscope to be practically free from the organic matters which should not be included in the food of the oyster."

After my study of the North Carolina oyster, I can hardly agree that the above method is in any way reliable in the data it supplies, and, since it may prove to be of economic importance to be able to determine, previous to an expensive oyster-planting operation, the food resources of a locality, I have endeavored to perfect a method which will be fairly accurate in its results. My reasons for discarding Dean's chemical test for a microscopical examination of the water are: (1) No matter how carefully the specimen of water has been collected it is sure to contain an abundance of organic impurities, which do not quickly settle but remain in suspension for a considerable time—several hours. (2) Among the first things to settle to the bottom, when the water is freed from currents, are some of the largest and most valuable food forms of the oyster—for example, *Eupodiscus*, *Coscinodiscus*, and *Melosira* (see figures, page 285); while among the last to settle are the light spiny diatoms of which the oyster can make no use and of which the water is so full—for example, *Nitzschia* and *Rhizosilenia*. The former would not be included in the chemical test,

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[a] H. F. Moore: Report on the Oyster Beds of (14) Louisiana. U. S. F. C. Report, 1898, pp. 45-100.
[b] Bashford Dean: "The Physical and Biological Characteristics of the Natural Oyster Grounds of South Carolina." Bull. U. S. F. C., 1890, pp. 335-361.

whereas the latter would. (3) Copepods and other small crustacea, and various larval forms which are so very common at times in all salt and brackish waters, form no appreciable part of the oyster's diet, yet these would be included in a chemical analysis. (4) While an oyster depends wholly upon what the currents bring within reach of its cilia, it does not passively accept all that is brought. I have abundant reason for believing that the oyster possesses a limited amount of selective power in feeding and is able in a measure to discard objectionable forms. Very active creatures, like small crustacea and larvæ, are seldom caught, being able to free themselves from the incurrent streams of water set up by the ciliary movements of the oyster.

From the above facts it can be readily seen that before any determination of the food value of the water of a certain locality can be made it must be known what forms existing there constitute the oyster's diet, and the conclusions must be based upon the abundance of these forms and not upon the abundance of organic forms in general. The method followed in these investigations, which proves to be fairly accurate, was carried out as follows: A liter of water was carefully collected 1 foot from the bottom in the locality under consideration. This was done by lashing a bottle of 1 liter capacity 1 foot from the end of a pole. When the pole was thrust to the bottom the cork was drawn by a string attached to it, and when the bottle had filled it was brought to the surface and unlashed, recorked, and labeled. A number of oysters were then tonged from the same locality[a] and three were chosen which had a length of not less than 3 and not more than 4 inches. The contents of their stomachs were removed by means of a medicine dropper thrust into the stomach after one shell had been removed, a very simple process when the position of the stomach is known. The stomach contents were examined as soon after removal as practicable. The amount taken from three oysters was found to be seldom more than 10 cc. When less, water was added; when more, it was allowed to settle and the clear surface liquid was removed, the examination thus beginning each time with 10 cc. of the food solution. This liquid was violently shaken in a bottle and 1 cc. quickly removed and put into a Rafter cell,[b] where it was carefully examined and the number of food forms estimated, the process being repeated twice. From the three estimates thus obtained the amount of oyster food in the entire 10 cc. was calculated, and this divided by 3 gave the amount per oyster.

The specimen of water was allowed to stand for eighteen to twenty-four hours, until all the sediment and organisms (except small crustacea and swimming larvæ) had settled and formed a definite layer on

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[a] If it be desired to determine the food resources of a locality in which no oysters are found it is only necessary to plant a few oysters a few days before the examination is made.

[b] The Rafter cell and the method of using it are described on pages 366-367 of J. I. Peck's report on "The Sources of Marine Food," U. S. F. C. Bull. for 1895.

the bottom of the bottle. In localities where Peridineæ were found to constitute a perceptible part of the diet of the oysters, formalin (20 cc. per liter) was added to the water, it having been found that otherwise these plants were all lost in removing the water, which was carefully siphoned off to as low a level as possible without disturbing the settlings. The water and settlings remaining in the bottle after two rinsings were put into a smaller bottle (6-ounce wide-mouth) and again allowed to settle. After a second siphoning away of the clear water the settlings had a volume not exceeding 15 cc., and the diatoms and other organisms in this residue which belong to the species that have been found to make up the diet of the oysters, were counted in the same way as those in the stomach contents.

There are usually to be found in an oyster's stomach, or in the settlings from a specimen of water, several species of organisms, chiefly diatoms, and most of them minute forms. I have found by calculation that the food contents of a given liquid may be very accurately expressed by considering the number of the large forms only; for example, it was found that one *Eupodiscus radiatus* is equal in volume to more than one hundred and fifty individuals of the small species of *Coscinodiscus*, and although the latter is quite numerous in oysters from Newport and North rivers, it may be discarded without affecting the result.

Observations as to the food resources in Newport and North rivers were made and recorded weekly during the summer seasons of 1900, 1901, and 1902. From these records have been made the monthly averages which appear in the food tables on page 289. The examinations made in Pamlico Sound covered but short periods of time, in 1900, so that in each case one average only has been made.

The methods used by Moore in his work in Louisiana differ from those just described only in that all species of diatoms found in the water were counted and given as the food value of Louisiana waters. When, therefore, in his report on the oyster beds of Louisiana (p. 54), Moore states that the food value of the water over the beds in False Mouth Bay is 22,000 diatoms per liter, it does not follow that the supply of available oyster food in that locality is greater than that in the Beaufort region, where I have found each liter to contain about 14,654[a], for if all species of diatoms had been counted in the latter place the number would have been fully equal to and usually greater than that given by Moore.

The method devised for determining the time required by an oyster to get a certain amount of food from the water is described on page 291.

For ascertaining the condition of individual oyster beds the methods were suggested by, and carried out under the direction of, Capt. J. A. Smith, of the *Fish Hawk*. The oystermen were questioned as to the

[a] The average from results of the work of three seasons in Newport and North rivers.

usual catch they had been able to make on the beds, and this information was supplemented by the results we were able to get by tonging and dredging the beds.

In our tonging operations a certain definite area was covered, and an accurate count made of everything brought up by the tongs, including marketable oysters, small oysters, spat, shells, and other animals.

For the examinations by dredging, a regular oyster dredge boat was hired, and towed over the oyster beds in various courses by a steam launch. When the dredge on one side of the schooner had been on the bottom one minute it was hauled in and emptied, the one on the other side being let down. This was continued until the schooner had crossed the bed, when another line of dredgings was begun. The contents of each dredge haul were examined and counted. The exact position of the schooner at each haul was determined by sextant angles, signals having been erected on shore for this purpose before the work began. On certain beds in Pamlico Sound, which were exposed to the action of waves, oyster shells with their hinges intact were abundant. These were thought to indicate the amount of damage done to the beds by the recent storms. It was evident that the oysters had recently died, whatever may have been the cause.

SURVEY OF NEWPORT AND NORTH RIVERS.

GENERAL CONDITIONS.

The survey of Newport and North rivers was conducted from the steamer *Fish Hawk*, the men being transported to and from the oyster beds in launches and row boats. The work covered the period from October 6 to November 23, 1899, in Newport River; from the latter date to January 7, 1900, in North River.

Before beginning the work in either case, signals were erected by Captain Smith at various places along the shores, to be used in making triangulations of the oyster-producing regions. From these angles and the sketches and observations thus made, charts were constructed by Mr. W. F. Hill, giving the location and extent of each of the natural and planted oyster beds, the depth of the water covering them, and the character of the bottom. The positions of the stations at which observations were regularly made on the density of the water and the velocity of the currents are also shown, and in connection therewith the averages for the entire survey of the observations made at each. A record of the density observations at certain of these stations during the three seasons immediately following the survey are given in the food tables on page 289.

The total areas of the natural oyster beds in Newport and North rivers and tributaries, including "reefs" and areas of scattered

oysters, were found to be 257.7 and 135.22 acres, respectively. Comparing these figures with those given by Winslow for 1887, it is evident that during the twelve years that intervened the beds have become considerably reduced in size. Winslow gives 403 acres as the area of the Newport beds, not including those of Carrot Island, and 242.75 acres as the area of the beds of North River. His estimate that the entire area in each river not now occupied by natural beds was available and suitable for oyster culture in some of its branches is also very much greater than the estimate of Captain Smith, who, guided by the experience of those who have planted oysters in these waters since the survey by Winslow, gave 3,840 acres as the amount of ground suited to planting in Newport and 3,600 acres in North River. My own experience, acquired since the survey in 1899, would lead me to reduce the amount still more, limiting all planting to such unoccupied bottoms as are found above the lines referred to in the discussion of the natural beds on the next page.

The amount of ground under cultivation in Newport River at the time of Winslow's survey was 28 acres. In 1899, although as many as 170 entries of ground had been made since 1887, there were no beds on which the taxes for the previous year had been paid, and hence none to which a good title could be claimed. In North River, however, in 1899, there were 500 acres of ground which had been preempted for oyster culture, on most of which more or less planting had been done and on which the taxes were paid. The amount of ground under cultivation at the time of the survey by Winslow was 310 acres.

These waters are more like bays than rivers, their courses being very short and their mouths very wide. The mouths, moreover, are more or less filled with extensive low islands covered with tall marsh grass, separated from each other by shallow channels, and from the mainland by wider and deeper ones, which are used by the oystermen and fishermen in navigating the rivers. The supply of fresh water is furnished by seepage from the extensive marshes lying about the headwaters of the streams, and is ordinarily so limited that the currents are almost wholly due to the tide. The fresh water reaches the rivers either directly or through small shallow streams which penetrate the marsh lands, and except during very dry or very wet seasons the supply, although limited, is constant, flowing into the rivers at various points in their courses and meeting and mixing with the salt water brought up by the tides. At and near the sources the water is usually quite fresh, but the density gradually increases with the downward course of the streams until by the time the mouths are reached the salt water is so largely predominant that the effect of the fresh is scarcely perceptible. This condition explains the fact that the oyster

beds which regularly produce oysters marketable as "selects" are limited to the upper parts of the rivers. These oysters will live in pure sea water, and are not immediately killed by water which is almost fresh, but they thrive best in water which has a specific gravity of about 1.014.[a]

During a season of very great drought, however, the water over the beds in the upper parts of North River becomes more dense than at the mouth or at Beaufort Inlet, this peculiar condition being brought about by evaporation. The water in the upper part of the river is very shallow, but is spread out over a large area. Before it is carried past the river's mouth the tide changes, and, since there is no fresh-water supply, the same water is returned, day by day growing more salt. In August, 1900, when a density of 1.023 was noted at Beaufort Inlet, a density of 1.0248 was noted at the station near the Sunken Rock beds. It is also quite common after heavy winds from the northeast and east to find the water at the mouth of this river less dense than over the oyster beds farther up, brackish water having been blown down through Core Sound from Pamlico. This occurred on November 28, 1899, the density at the river's mouth being 1.0142, while over the planted area (station 7) it was 1.0162.

In summer the temperature of the water becomes very high, especially on days when low water occurs near midday, 93° F. having been noted above Harlow Creek in Newport, and on the experimental bed in North River at such times. In winter ice often forms over the beds, killing the oysters which are exposed or which are in very shallow water.

From tide gauges located at the Morehead City railroad wharf and at Lenoxville during the survey, and later from the gauge at the Fish Commission laboratory at Beaufort, the average daily vertical range of the tides in the harbor was found to be about 3.5 feet, with a maximum height of 5.2 feet. High winds modify to a considerable extent the height of the tides and to less degree their regularity, but usually the periods of ebb and flow take place with mathematical regularity, five hours flood being followed by seven hours ebb. The stages of the tides on the natural oyster grounds, which, in both rivers, are located about 8 nautical miles from the jetties at Fort Macon, have been found to occur two and one-fourth hours later than the corresponding stages at the latter places.

As was mentioned above, lines can be drawn in both rivers separating with a fair degree of accuracy the beds that produce a good quality of oysters from those that do not. In Newport River such a line would reach from a point just below the mouth of Harlow Creek to the oyster signal "Willis" on the opposite shore. In North River it would connect a point half way between the mouth of the small creek below

[a] Fresh water has a specific gravity of 1.000; that of sea water is about 1.025.

Gillikins's windmill and Wards Creek with oyster signal "Sandy," exception being made of the beds in the upper part of Wards Creek. During wet seasons these lines would be farther down, during a period of drought farther up the rivers. The oysters from the lower beds are misshaped, ill flavored, and usually poor, and are used only by the canneries in putting up their poorest grade of stock.

The bottom in the upper parts of both rivers between the oyster beds is principally made up of black mud, although areas of hard white sand, considerable in extent, are also found. The muddy bottoms are either soft, sticky, or hard, a variable amount of sand and shell fragments being mixed with a fine, light, organic débris. The layer of mud varies in thickness from a few inches to several feet and rests upon a substratum sometimes of clay, sometimes of sand.

These extensive mud flats are the source of a considerable part of the oyster's food supply in these streams. Diatoms of many species live and multiply on the mud surfaces in such numbers that on perfectly calm days they give to the mud their yellowish-brown color, and, with the light surface layer of the mud, are easily taken up by the waves and currents and carried over the oyster beds, thousands in each quart of water. The food supply is made up of the same species of diatoms in both rivers, but during the periods when observations were made the quantity in Newport River considerably exceeded that in North River, and in the upper parts of both streams the supply was greater than in the parts below. In Newport River the food is more available to the oysters because of the more rapid currents. The food question is discussed elsewhere.

The bottom in the upper part of Newport River has a much more uneven surface than that in the corresponding part of North River, the result being that swifter currents are developed in the former than in the latter. In North River above the mouth of Wards Creek, the water is fairly uniform in depth, and in consequence becomes evenly distributed over the whole area. The general flow which takes place over the Sunken Rocks seldom attains a velocity greater than one-eighth mile per hour. In Newport River, on the other hand, in the vicinity of the Cross Rock beds, a velocity of one-half mile per hour is reached in the channels, and the oyster beds are so located that they are washed by the currents, the formation of the beds interrupting the channels and forcing the water to flow around.

NATURAL OYSTER BEDS.

The natural oyster beds of these rivers may best be described under two headings—reefs and tonging grounds.

Reefs.—Oyster reefs occur in both rivers from source to mouth, and each of the larger ones has been given a name by which it is known among the oystermen and fishermen. They are long, narrow ridges of mud and shells, the tops usually covered with a dense growth of

badly shaped oysters known as "coons." The long axes of the reefs are usually at right angles to the shore line, but a study of the conditions under which they have been produced shows that their position depends upon the direction not of the shore line but of the currents which flowed past them during their growth, the formation always making right angles with the direction of flow. The reefs are considerably higher than the surrounding areas, and at low tide for a longer or shorter period of each day they are not covered by the water. When thus exposed to the air the oysters are not only unable to feed, but are often subject to the extremes of summer and winter temperatures. The poor quality of those growing on the reefs may be due in part to these adverse conditions; their ill shape, however, is due to crowding that takes place among individuals, for although not favorable to the growth of adult oysters, the conditions on the reefs are most favorable for the attachment and growth of spat.

From a commercial point of view the oysters produced on the reefs are considered almost useless, although they have been sometimes used by the canneries in putting up their poorest stock. The chief value of reef oysters is to be found in the supply of spawn they furnish to the oyster beds located in deeper water. No matter how much the latter beds may be depleted of spawners, they are quickly restocked from the spawn of the oysters on the reefs.

A living reef, when closely examined, is found to be made up of clusters of oysters, each rooted in a substratum of soft organic mud mixed with shells and shell fragments. Between the clusters numbers of mussels, crabs, and worms are also usually present. The individual oysters of a cluster are long and narrow, and from their fancied resemblance to the paw of a raccoon, it is supposed, are known as "coons."

A cluster is a peculiar colony, representing from three to seven generations of oysters, all but two to four of them dead. Each generation becomes attached to the shells of the preceding, and thus the cluster grows wider and higher in a way which may be described by comparing it to a genealogical tree. The oldest or lowest oysters, dying either from being crowded by the oysters above or smothered by the sediment below, leave their empty shells as anchors or supports to the colony. Sediment is constantly deposited between the clusters, the bottom thus keeping pace with the upward growth of the oysters. The individuals of a cluster assume a vertical position, with mouth uppermost, and, crowded on all sides by their neighbors, they can grow only in the remaining direction—from their free ends.

On examining the immediate vicinity of a reef when it is not covered with water a strong current is found at the outer end, the direction of the flow at right angles to the long axis of the reef. A short distance either above or below the reef are more sluggish currents, either par-

LIMEKILN ROCK, NEWPORT RIVER, A TYPICAL OYSTER REEF.

A SECTION OF THE SURFACE OF LIMEKILN ROCK, SHOWING MUSSELS BETWEEN THE "COON" OYSTERS.

allel to the long axis or in long curves and eddies. The water at the immediate edges of the reef has still less motion. These conditions I have sought to illustrate in figure 1, on page 262. Their effect is readily seen; the oysters and shells at the end of the reef, where the swift current sweeps past, are always washed clear of sediment, while above and below the reef the conditions are favorable to the deposition and collection of the silt, which is ever present in large quantities in the water of Newport and North rivers.

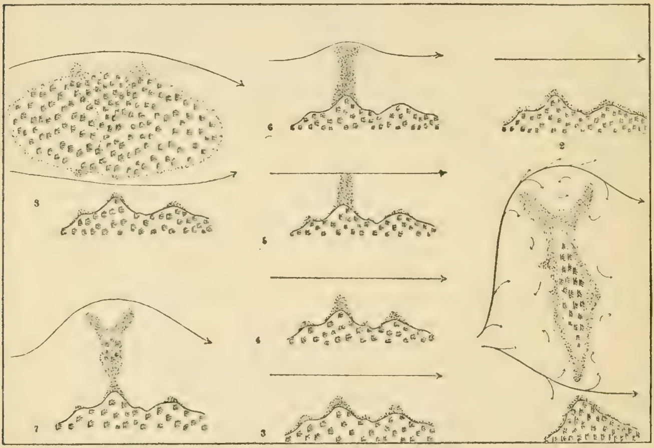
Young oysters at the end of their free swimming life attach themselves to almost any object, whether suitable or unsuitable, which happens to be at hand when the critical attaching stage is reached, but only those survive that chance to settle on hard smooth surfaces and in places practically free from sediment. The oyster at the time of its attachment is so small and delicate that it is easily smothered. For this reason, in Newport and North rivers, of the millions of young oysters that attach themselves every season, comparatively few ever come to maturity. It will thus be readily seen that the most favorable places on a reef for the attachment of spat are the oysters and shells at the end, where there is no danger of being overwhelmed by sediment, and food is carried past their mouths in constant abundance. It is very different at the sides of the reef; some of the young oysters settle where there are coatings of sediment, which kills them immediately; others succumb soon after attachment to the silt which, no longer held in suspension by the water when checked in its motion by the reef, is constantly being drizzled upon them and carried into their gills. The oysters that survive are comparatively few. The soft bottom just beyond and at the sides of a reef is gradually hardened by the oysters and shells that fall or are knocked from the top of the reef; but at the ends many of the living oysters that fall beyond the reef survive, and their shells afford places for the attachment of spat a little farther out than were before available. There are thus two formative processes at work, building more rapidly at the end than at the sides of the reef.

The manner of origin and growth of existing reefs is not only very interesting, but instructive, for in it is illustrated nature's method of preparing soft muddy bottoms for the growth of oysters; and if it can be copied by man, it is a method by which many of the now barren muddy areas in the Beaufort region and in Pamlico Sound may be made to produce oysters of good quality. The substratum of the present oyster reefs is hard, but they are, with few exceptions, surrounded by deep, soft mud, and, as I will endeavor to show, there is every reason to believe that the bottom where they now stand was once not different from the surrounding mud flats.

The banks of the rivers and harbor have always presented numerous objects with smooth, hard surfaces to which oysters might become

attached, and even now there is a more or less continuous fringe of oysters skirting the shores of the rivers and marshes. Young ones are also found adhering to shells and other solid objects which have been for some time firmly stranded on the shoals out in the rivers. Permanent objects, however, do not usually exist on the shoals; a conch shell, for instance, may lie undisturbed for weeks and become covered with spat, but sooner or later currents of unusual strength are developed by winds, and the shell with its little colony is swept away or covered up.

Starting with the fringe of oysters referred to, however, or with small colonies attached to such objects as may be stranded on the shoals, I will endeavor to show how the reefs may have been produced



Scheme illustrating the conditions near an oyster reef and the steps by which a reef may be formed. Dots represent oysters. Arrows represent water currents. Irregular line represents shore line. Groups of short lines represent marsh grass.

through the action and reaction of the conditions described. Because of their nearness to flowing water, the oysters living on the points on the shore where the river bends, or on points which project into the stream, are kept clearer of sediment and are supplied with a greater amount of food than their less fortunate fellows attached to objects in more sheltered places. To be brief, the conditions surrounding the oysters living in such exposed places are the same as those previously described for the vicinity of a reef. Figures 2, 3, 4, and 5 illustrate the effect of these conditions in producing at first a collection of clusters on the projecting points, then an extension of the clusters, forming a bar of oysters toward the current channel. As this bar increases in length it causes a gradual slackening of the inshore currents, with

consequent reduction and the final disappearance of the adjacent oysters on shore. The growth of the bar continues, finally reaching the current channel, where its further growth results in forcing the current to bend away from the reef and cut a new channel farther out. The currents thus no longer flow straight past the end of the reef, but strike it at an angle less than 90°, making new conditions, under which the most rapid growth of oysters, at right angles to the flow of the displaced currents, is no longer in the original direction of the reef. A branching of the reef at its end is thus brought about, as is shown in figures 6 and 7.

As the reef continues to grow in length, its damming effect upon the volume of water, which must twice each day find its way up and down the river, increases, and there comes a time when the reef is no longer able to force the entire stream around its outer end. A break must occur at some point in the reef, and in nearly all cases in Newport and North rivers this has taken place at a point a few yards from the shore. Reefs originating from points in the river would of course grow from both ends, and a break in their length would not be likely to occur, since wide open ways for the water are left at either end.

Reefs of recent formation are low and very narrow in proportion to their length, and clusters of living oysters are found evenly distributed over their areas. The patches of oysters in the center, however, in time are covered and killed by the sand, mud, and shells washed up and deposited upon them by the waves, the reefs thus gradually becoming higher and wider (fig. 1). With the accumulation of this débris year by year the high-water mark is gradually reached. Successive catches of spat, which spread over the top of the reef, are repeatedly covered, and finally a plane is reached so near high-water mark that the period of time during which the oysters are covered by water is too short to allow them to collect the minimum amount of food required. Examples of such high, permanently dead reefs are found in both rivers. They are conspicuous objects on clear days, for the bleached shells and white sand of which they are composed reflect the light and give an appearance of dazzling whiteness.

Grass finally takes root on the high oysterless patches on the old formations, and then the "white" reefs begin their transformation into "green" reefs. The grassy islands found in various places in the rivers are usually very low and marshy, with only a fringe of living oysters around them, but there are a few which, in addition to the fringe of oysters, have a hard shelly center. This character, together with their position in the rivers, suggests their probable origin from oyster reefs. When a reef is young and low, its growth in length is rapid until the limits are reached. Its upward growth is restricted to the height at which the oysters are able to catch sufficient food. Each reef, however, acts as a dam in catching and holding extensive areas

of sediment both above and below, and year by year these areas become higher and higher, until they finally reach the height of the reef. Grass then spreads over the whole and an island is formed with a width greater than the original length of the reef from which it started (fig. 8).

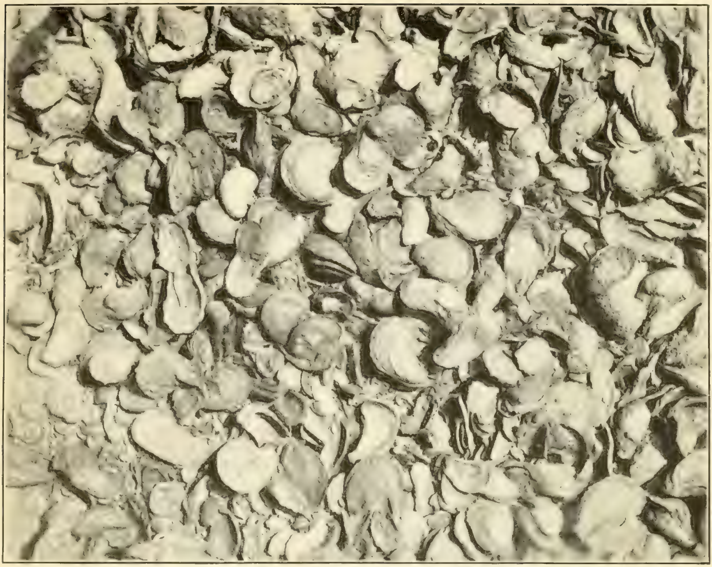
The conditions of some of the typical living reefs of Newport River are shown in the table below. The figures represent what was found on a square foot of the surface on the highest part of each reef. A photograph also is reproduced, which gives a better idea of the appearance of the oysters and their distribution on the reef.

Name.	Oyster clusters.	Adult oysters.	Spat.	Shells.	Mussels.	Mud crabs.
Cross rock	22	43	108	60	37	5
Green rock	21	32	137	26	97	2
Limekiln rock	19	47	120	50	28	4
"A" rock	21	55	163	52	49	4

In addition to the above, worms are abundant in the mud about the roots of the oyster clusters, and an occasional clam is also found. Barnacles cover the shells of oysters wherever found. On the reefs near the mouths of the rivers, sea anemones and a species of shrimp are abundant.

Tonging grounds.—The natural oyster beds from which salable oysters are annually obtained by the tongers lie in the upper halves of the rivers and in certain similar localities in their principal head-water tributaries. Those tributaries which join the lower halves of the rivers have no tonging grounds of importance, but contain only such reefs as those found in the parts of the rivers into which they flow.

Every tonging ground is associated with a reef. They are found in some instances apparently independent (Lawtons Rock in Newport and Sunken Rock in North River), but in these cases the reefs have been cut down and hauled away for use as fertilizer on farm land or in the manufacture of lime. Each tonging ground consists of a strip of hard or sticky bottom of varying width, and extends along either one or both sides of a reef below low-water mark. The hardness of the bottom on these strips is in nearly every case due to the shells that have fallen from the adjoining reef. Such portions as have been sufficiently hardened to support single oysters at the sides of very young reefs or along those surrounded by very soft deep mud are too narrow to be of commercial value, but in the vicinity of some of the old reefs the tonging grounds are acres in extent, that around Sunken Rocks in North River, for example, containing 40 acres. Natural agencies only (winds, waves, rain, and ice) are at work in scattering shells and oysters over the bottoms adjacent to young reefs, and they work very slowly, but as soon as the hardened areas become sufficiently large to produce single oysters in considerable abundance the oystermen are attracted to them and their growth becomes more rapid, for



TURTLE ROCK, NEWPORT RIVER, SHOWING A SECTION OF TONGING AREA. (FROM PHOTOGRAPH TAKEN AT VERY LOW TIDE.)

A TYPICAL TONG BOAT, SHOWING TONG MEN AT WORK.

in tonging oysters and returning the cullings to the bed the soft bottoms beyond the hard are rapidly filled with shells.

Aside from the few oysters annually carried from the reefs by waves and ice and deposited upon them, the tonging grounds are stocked from the young free-swimming oysters that attach themselves to the exposed shells. The amount of spat caught by the shells varies from year to year, the climatic conditions at times being such that practically no catch is made. From the results obtained in the planting experiments carried on during 1900, 1901, and 1902 it appears that spat become attached in greatest abundance when the specific gravity of the water is from 1.010 to 1.017. In Newport River a dry season brings about the most favorable conditions, but in North River the best results are obtained when the amount of rainfall is greater than usual. The condition of the shells, too, has much to do with the amount of spat that becomes attached. If the shells are covered with sediment or coated with "slime" the oysters are killed, their structure and size at this stage being such that they are easily smothered.

The sediment that settles upon shells in quiet water is easily removed by wave motion during high winds, and it probably has little effect upon the catch of spat during a season, but when "slime" accumulates it is not so easily removed. By "slime" is meant any growth that brings about a foulness of the surface of the shells. This may be a vegetable growth (diatoms or algæ), or it may be brought about by animals (sponges, bryozoa, hydroids, etc.). It is produced most rapidly and abundantly when the water is salt, the plants and animals thriving best in pure sea water, and it is effectively removed when the water becomes brackish. On this account the shells on the beds situated in the upper parts of the rivers are usually quite free from slime and a good catch of spat is annually counted upon, but those on the beds lower down often become very foul and worthless as spat collectors.

Oysters grown on the tonging grounds owe their superiority to reef oysters to the fact that, not being crowded, each oyster not only has room for normal growth but is well supplied with food. As has been mentioned in other places in this report, the food resources of these rivers are adequate for many times the number of oysters now produced, provided the oysters do not lie too close together. In places on the tonging grounds spat often covers the shells when they happen to be unusually clean, and the result is bunches of oysters in which the individuals are just as ill-shaped and unsalable as those on the reefs. The water flowing past such a bunch of oysters is the same in amount as that which supplies an oyster growing singly, and contains the same amount of available food, but in the one case several mouths share what, in the other, is available for one. It is not surprising, therefore, that oysters growing in clusters, whether found on reefs or on tonging grounds, are usually poor.

The depth of water over the tonging grounds varies at low water from a few inches to not more than 7 feet, so that dredges can not be used. The size of the beds, however, is not such as to attract dredgers, only a few weeks being required after the season opens for the tongers to catch the stock which has grown during the year. Before the opening of canning establishments at Beaufort, the beds were much more prolific than now, the usual daily catch at that time being from 25 to 40 bushels of oysters. The increased demand made by the canneries led to the over-fishing of the beds, and at the time of the survey the daily catch for a tong boat had been reduced to 8 or 10 tubs.[a] In taking this quantity of oysters it was necessary for the oystermen to handle an immense quantity of cullings, as is shown by the results of tongings made on a few of the typical beds in Newport River by the surveying party. In gathering 1 peck of salable oysters, there were handled on the bed below Limekiln Rock 160 small oysters and spat, and 1,060 shells; on the bed above Limekiln Rock, 154 small oysters and spat and 536 shells; on the bed below Cross Rock, 82 small oysters and spat and 400 shells. The beds in North River are in about the same condition.

The oystermen do their tonging from small sailing skiffs 15 to 25 feet in length. Each skiff is usually manned by two persons—a man to tong and a man or a boy to cull. When the bed is reached the sail is furled, and laid, with the mast, in the bow of the skiff. The tonger works from the stern, dumping the stock, just as taken from the bed, upon a wide culling board laid across the boat amidships. The culler, armed with a short stout stick, goes over the stock, separating the salable from the undersized oysters, shells, and other débris, returning the cullings to the bed and throwing the oysters into the boat. The tongs used by the oystermen are made by local blacksmiths and carpenters, with shafts from 10 to 16 feet in length and heads containing 12 to 16 teeth. The implements and the methods of using them are shown in various photographs reproduced in the report.

The price received by the tongers for the oysters taken to the canneries is seldom more than 18 cents per tub, and it is often less. When "raw houses" are running, however, the price for the best stock is higher, 25 to 40 cents being received. The tongers often carry their catch to the canneries in their skiffs, but during the busiest part of the season the canneries send large sharpies, known as "buy-boats," to the beds to buy from the oystermen. Less time is lost in this way, many of the tongers remaining over night in the tonging region, ready to begin work at sunrise.

The largest and best single oysters produced in the Beaufort region come from an area in North River lying above Jacks Island Reef, out-

[a] The "tub" is the standard measure adopted by the canneries, and holds $1\frac{1}{4}$ bushels.

side the regular tonging beds. The oysters are not sufficiently numerous on this area to be tonged in the ordinary way, but during very calm weather when the water is perfectly clear, the oystermen pole their boats about over the bottom, picking up the oysters one by one as they see them, using for the purpose tongs with very narrow heads, locally known as "nippers." The supply of oysters on this area is very limited, and they bring from 40 to 75 cents per bushel. In Newport River single oysters are found only on the tonging grounds, the bottom between the beds being too soft to support them.

The tonging grounds of both rivers produce clams in abundance, and when the oyster season is over or when tonging for oysters becomes unprofitable, the beds continue to be worked for clams. Mud crabs, barnacles, worms, snails, and boring sponges are also found with the oysters, but they are not usually in sufficient abundance to be detrimental.

The quality of the oysters produced on the tonging beds is not the same from year to year, but varies with the climatic conditions, which affect the two rivers differently. For a few years previous to the survey the beds of North River had the reputation of producing oysters much finer than those grown in Newport, but this was reversed in 1899, since which time the Newport oysters have been considered the best in every particular. During this period the food supply in Newport has been richer than that of North River, and the difference has been enough to account for the difference in result.

The food of the oysters on the Sunden Rock beds and the richness of the food supply in the water over them, as shown by a few examinations made during the summer of 1900, is given in the table which follows.[a]

Food found in the stomach of an oyster 3½ inches in length, and in a liter (about 1 quart) of water.

	Melosira sculpta.	Pleurosigma spencerii.	Eupodiscus radiatus.	Navicula didyma.	Total.
Oyster	8,057	485	1,058	5,312	14,912
Water	3,621	7,590	1,173	1,712	14,096

During the survey (November 23 to January 6, 1900) the density of the water over these beds averaged 1.0189 at surface and 1.019 at bottom, high tide; at low tide, the reading was 1.0163 at both surface and bottom. During the summer of 1900 the average was as follows:

Density over Sunken Rock beds.

Month.	High-tide surface.	Low-tide surface.
May	1.0178	1.016
June	1.0212	1.0206
July	1.0243	1.0238
August	1.0246	1.024

[a] This table should be compared with that for the Cross Rock Beds, on page 289.

The future history of the oyster beds of these rivers is likely to be similar to the past, periods of productiveness followed by longer or shorter intervals during which the oysters are not salable. These changes may be brought about by a combination of factors, but the one having the greatest influence is probably the specific gravity of the water.

PLANTED GROUNDS.

Oysters were first planted in the Beaufort region about the year 1840, a Mr. Hardesty having bedded a small quantity during that year at the head of Harlow Creek. Many such plantings were made from this time until about 1859, and many of the beds then planted have continued to the present. The idea of the planters was not to raise oysters for commercial purposes, but for their own use, as is shown by the name which they gave to their beds—"oyster gardens"—a name, by the way, which has been retained throughout the State for all planted grounds.

During the survey the Hardesty bed was examined on several occasions and several bushels of the oysters were used on the *Fish Hawk*. They were large, well shaped, and in excellent condition. The area of the planted ground is necessarily small, being situated in a bend in the creek about 1½ miles from its mouth. The bottom is hard now, although originally it was probably quite soft, like the bottoms above and below the bed. The density of the water is subject to great and rapid fluctuations, the supply of salt water, coming from Newport River and at times from the Neuse through the "Club Foot" Canal, being greatly influenced by the wind. An abundant supply of fresh water flows in from the extensive marshes lying all about. The minimum density noted over the bed was 1.0028 and the maximum 1.0164; the depth of the water is from 4 to 7 feet. It is the supposition of the oystermen that the oysters here are fattened by food which comes with the fresh water from the marshes; examinations did not confirm this view, however, but showed that the food comes from the same salt and brackish-water sources that supply the oysters of Newport River. This bed has been mentioned because it is an example of a continuously successful one, situated in a place which has no more to commend it to an oyster planter than numerous other larger areas in Newport and North rivers.

The following table, compiled by Mr. C. H. Stevenson, shows the number and acreage of the oyster gardens made in the waters of Carteret County since 1872. The number of beds made before this date can not be accurately ascertained, since it was not then necessary to have the entries authorized by law, and no record of them has been kept by the clerks of the court.

TONG BOATS IN PORT.

A "BUY BOAT" ANCHORED TO BUY OYSTERS FROM THE TONGERS.

Acreage of oyster gardens in Carteret County.

Year.	Number.	Acres.	Year.	Number.	Acres.	Year.	Number.	Acres.
1876	1	7	1884	96	911	1892	77	763
1877	1	9	1885	34	324	1893	19	184
1878	8	74	1886	53	496	1894	4	38
1879	1	8	1887	28	273	1895	1	10
1880	2	17	1888	4	40	1896	39	367
1881	2	20	1889	108	1,042	1897	20	182
1882	5	47	1890	162	1,512	1898	2	20
1883	4	37	1891	157	1,467			

Total, 828 beds, aggregating 7,848 acres.

Of this total, 107 beds were located in Newport River, and even a larger number in North River. Nearly every farmer, oysterman, fisherman, and business man living in the vicinity of these waters has at some time made an entry of ground and planted some oysters. In 1899, however, the beds in Newport River had all been abandoned, and in North River there were only about 30 beds on which the taxes had been paid. In the entire county the total number of beds held at that time was 130, covering 1,099 acres.

The failure of the attempts at oyster culture thus far can not be attributed wholly to inexperience on the part of the planters, for the most extensive efforts in Newport and North rivers have been the work of men from the North who had had experience in oyster planting. The methods suited to conditions in the North, however, may not have been adapted to those in North Carolina. Mr. J. N. Ives, from New Jersey, planted extensively in Newport River in 1875 and in North River in 1891. The oysters in North River lived, but were not superior to those raised on the natural beds. Oystermen took up the oysters from his beds the second season after they were planted and sold them to Mr. Ives, who was then operating a raw house in Newbern. The oysters on his Newport bed thrived for one season, but died in great numbers during the second. Mr. E. L. Gandy, also from New Jersey, made an extensive plant in Newport River, but the oysters remained poor and unsalable year after year, and he finally abandoned the bed. The ground selected was excellently adapted to growing oysters, and Mr. Gandy attributed his failure to too great variation in the density of the water. He also thinks there are more oysters in the river than can obtain a sufficient amount of food.

Various reasons are given by the oystermen for the failure of planted oysters, most important of which are the following:

(1) Insecurity of title, depriving the owners of protection against trespass.

(2) A high rate of mortality among planted oysters.

(3) Failure of the planted oysters to become fat during the season when they should be marketed.

The first of these difficulties can be eliminated by the enactment and enforcement of laws more favorable to oyster culture. The second and

third are, in my judgment, due to the location of the planted beds in places where the water is almost universally more dense than is favorable to the growth of salable oysters, and can also be eliminated to a considerable extent in future plantings, if it be made possible by law to preempt the areas not occupied by oysters in the vicinity of the natural beds. It has been necessary, hitherto, for the planters, in order to avoid litigation and to receive legal protection, not only to take up no natural oyster bed, but to keep far from such grounds. The result has been that most of the planted beds in both rivers have been located below the lines marking the limits of natural beds regularly producing salable oysters, and where the conditions are too seldom favorable to make planted oysters a profitable investment.

The conditions on the areas occupied by the planted beds are, however, sometimes favorable to the production of good oysters. In 1899 the oysters on the beds abandoned by Mr. Gandy became fat, and furnished employment for several tongers throughout the season. It was estimated that there were enough oysters removed from his beds at this time to have repaid Mr. Gandy for all the expense incurred in planting, for the oysters were large and in excellent condition, bringing from 40 to 60 cents per bushel. In 1895 and 1896 planted oysters in North River were valuable, and there have been other years when it was profitable to take them up.

That the failure of oyster planting in these waters is not due to a lack of proper food was demonstrated by examination of the water collected simultaneously from natural and planted beds. The results of this examination are shown in the food tables on pages 272 and 289.[a]

The enemies of the oysters of North Carolina are not numerous when compared to those with which the oysters in the North have to contend. Starfish do not visit the beds at all and "drills" do no appreciable damage. There is, however, a parasitic worm (*Bucephalus cuculus*) common in the oysters on both the natural and planted beds in the Beaufort region, which may possibly have been accountable for the high death rate among planted oysters during certain years. It is not a parasite peculiar to the oysters of Beaufort, but is found in oysters from the beds in Pamlico Sound, Chesapeake Bay, and South Carolina waters.[b] The exact effect on the oysters is not known and is a subject which merits investigation. The way in which the oysters become infected with the worm is also a subject about which very little is known, but this probably occurs when the oyster is feeding, the larvæ coming into the shell with the stream of water drawn in by the gills, and fastening themselves to the soft parts of the oyster. Once attached, the parasite grows rapidly, soon filling the body of the oyster with its offspring and completely riddling the tissues with holes. It seems also to spread from one oyster to another—at least,

[a] See also page 292.

[b] I am indebted to Dr. D. H. Tennent for this information.

infested oysters are much more numerous on certain beds than on others.

The parasite may not be the direct cause of the death of oysters it infests, but they are necessarily much less vigorous and less able to withstand unfavorable conditions. The fact that the death rate on planted beds is much higher than on the natural beds may be due to the combined effect of the parasite and the less favorable physical conditions.

As uniform conditions exist throughout the region in each river that includes the greater number of planted beds, and as similar methods have been used by all the planters, for convenience in description, one bed in each river may be taken as a type.

Mr. E. L. Gandy selected ground near the middle of Newport River between the mouths of Harlow and Oyster creeks, and planted about 800 bushels per acre of unculled stock, tonged mostly from the beds in Harlow and Core creeks. The bottom at the place selected, composed partly of clay, partly of sand, is covered with a layer of soft, organic mud of varying thickness; a pole can be thrust into it to a depth of 6 to 15 inches. The water varies in depth from 3 to 9 feet at low tide, being deepest in the main river channel, which runs through one part of the bed. A velocity of 0.8 mile per hour was noted over the bed in the main channel at certain stages of the tide, and velocities of 0.5 and 0.6 mile per hour are common over the shallower parts of the ground. The density of the water varies greatly, being much lower on low or falling tide than when the water is rising or high. The drainage of fresh water from the vast area of low marsh lands at the head of the river and along the banks of Harlow Creek mixes with the salt water of the river and is carried over the bed as the tide flows out. Four density stations were located over this area. The first (No. 1), in the channel between Crab Point and the mouth of Core Creek, No. 2 near the north bank of the river and near the mouth of Oyster Creek, No. 3 opposite the mouth of Harlow Creek, and No. 4 south of the end of White Rock. The following tables give the average density at these stations, as determined by observations made at high and low water, from October 6 to November 23, 1899, and at two of these stations from May 1 to August 31, 1900. No corrections for temperature have been made:

Average densities over oyster bed in Newport River, planted by E. L. Gandy.

OCTOBER 6 TO NOVEMBER 23, 1899.

Station.	High tide.		Low tide.	
	Surface.	Bottom.	Surface.	Bottom.
1	1.0182	1.0187	1.0164	1.017
2	1.0176	1.0177	1.0156	1.0158
3	1.0163	1.017	1.0128	1.0156
4	1.0168	1.0169	1.0146	1.0166

Average densities over oyster bed in Newport River, planted by E. L. Gandy—Continued.

MAY 1 TO AUGUST 31, 1900.

Month.	Station 1.		Station 4.	
	Low tide.	High tide.	Low tide.	High tide.
May	1.0171	1.0198	1.016	1.0184
June	1.0192	1.020	1.0172	1.0186
July	1.0212	1.0214	1.0204	1.0219
August	1.0224	1.022	1.021	1.0222

The conditions existing at the time when the data for the first table were collected, were probably as favorable for oyster culture as are ever found in Newport River, and, as before stated, the planted oysters were in excellent condition, but even then the density over the lower part of the beds (stations 1 and 2) was too high for the best results. The gradual increase in density over the planted area during the following summer was due to the excessive dryness of the season, the fresh-water supply which usually comes from the low country about the head of the river being stopped altogether.

The food of oysters on the planted beds consists of the same species of microscopic plants that constitute the food on the natural beds, but numerous examinations during the summers of 1900, 1901, and 1902 show that the supply is not as abundant over the planted beds as it is farther up the river, and not of exactly the same quality. The following table, made from records of examinations of the stomach contents of medium-sized oysters from Mr. Gandy's beds and of water collected over the same in 1900, may be compared with the tables on page 289, which show the amount and quality of the supply over the natural beds.

Food found in stomachs of oysters from E. L. Gandy's beds in Newport River.

	Eupodiscus radiatus.	Melosira sculpta.	Pleurosigma spenserii.	Navicula didyma.	Total.
One oyster	847	1,922	6,990	642	10,401
Water (1 liter)	1,429	2,272	9,365	....	13,066

The most striking difference between Mr. Gandy's beds and the natural tonging grounds is to be found in the animals that live thereon. The variety and richness of the fauna on the planted beds is remarkable. Every tongful of oysters and shells brought up is conspicuous with bright colored sponges and leptogordias, which, together with many other animal species, are known to the oystermen as "moss." Four species of sponge are found, the most abundant being a boring sponge (*Cliona*), two leptogordias (yellow and red), three species of ascidians, two bryozoans, several species of worms, three crabs, and two drills, also oyster-fish and barnacles. The extreme saltness of

the water is the factor that makes it possible for many of these animals to live on the planted beds, and a reduction of the density but a few points would effectually exclude nearly all of those mentioned. Very few of the coinhabitants are directly injurious to the oysters, but they produce a foulness which catches sediment and prevents the attachment of spat. Drills destroy a few young oysters, and the boring sponge makes the shells brittle.

The oyster garden of Mr. J. W. Ireland, planted in 1891, may be taken as representative of the planted beds in North River. It lies just off the mouth of Roberts Bay in the region containing the greatest number of plantings, and has been as successful as any in the river. Here, as in Newport River, all the planted beds are below the area on which the productive natural beds are found. The bottom, a black, sticky mud, is very light and soft, and is composed of fine organic débris mixed with grains of sand and swarming with living diatoms. Below it gradually grows firmer and harder, the proportion of sand becoming larger, but in nearly every place not covered with shells or oysters, an oar can be thrust into it to a depth of from 9 inches to 2 feet. The water over the bed is about 3½ to 4 feet deep at low tide. The currents over this, as over all of the planted areas, seldom develop a velocity of more than one-third of a mile per hour. The specific gravity of the water is quite high, making possible an even denser growth of marine animals on the planted shells and oysters than was noted on the Newport planted oysters. The average density at stations 2, 3, and 7 during the period of the survey (November 23, 1899, to January 6, 1900) is given in the table which follows:

Average densities over oyster garden in North River planted by J. W. Ireland.

Station.	High tide.		Low tide.	
	Surface.	Bottom.	Surface.	Bottom.
2	1.0221	1.0227	1.0172	1.0173
3	1.0206	1.0207	1.0181	1.0183
7	1.0197	1.0199	1.0169	1.017

For the summer months of 1900, 1901, and 1902 the density shown in the food tables on page 289 for the experimental bed may be taken as representing Mr. Ireland's bed, for the northeast corner stake of the former marks the southwest corner of this oyster garden.

The method of planting used by Mr. Ireland was the same as that employed by all the North and Newport River planters. Unculled stock was brought down from the natural oyster beds at the head of the river, just as it was tonged, and spread broadcast over a portion of the bottom, stakes being set so that the same ground should not be

planted twice. The work was carefully done, but no estimate was made of the amount planted per acre. The bottom was in no way prepared for the oysters. They were placed directly upon it, the expectation being that the quantity of shells would be sufficient to prevent the oysters from sinking too deeply into the mud. It is evident, however, that the oysters were as likely to support the shells as were the shells to support the oysters, and from the number of black mud blisters which mark the interior of the shells and the frequent occurrence of completely "mudded-up" oysters, it seems that the bottom was too soft and should have been hardened before the planting.

At the time of the survey, however, there were not only on Mr. Ireland's, but on many of the planted grounds, numerous places where oysters were growing. The condition of Mr. Ireland's beds in two places is shown by the following table, in which is given the amount of cullings taken while tonging 1 peck of salable oysters from each:

Amount of cullings while tonging 1 peck of salable oysters on J. W. Ireland's bed.

Station.	Small oysters and spat.	Shells.	Mud crabs.	Oysters and shells with sponge.
1	111	440	14	70
2	135	316	9	168

During the month of November the oysters were watery and poor, but in December they became plump and white, and until April were in a marketable condition, although early in December those on Mr. Ireland's bed, as on all the natural and planted beds in the lower part of the river, became affected with the "green gill" (see below). The amount of food available for the oysters on this and the other planted beds in the immediate vicinity is shown in the tables on page 290, but it compares unfavorably with the amount available for oysters on the natural beds, as will be seen by comparison of this table with the one on page 267.

"GREEN GILL."

Soōn after beginning work in North River in 1899, the "coon" oysters at the mouth of Goose Creek Bay began to show a green color in their gills. In a week or so this was noticed in the oysters in Wards Creek also, and shortly afterwards those on the planted beds in Roberts Bay began to be affected. The color was very faint at first, but gradually deepened until the gills were the exact shade of a mass of *Oscillaria* filaments (a blue-green alga). Examination showed that among the cilia of the gill filaments and in the interfilamentary spaces, enormous numbers of a small, disk-shaped, granular, single-celled, blue-green alga were crowded. In this position they were growing and multiply-

ing with remarkable rapidity, and the oysters were utilizing the overflow for food, for those on the affected beds immediately became fat and their stomachs were full of the plant that was living in their gills. In no case were the plants found in the tissues of the oysters, but always external.

Only twice before do the oyster men remember that the "green gill" has affected North River oysters, and they state that at those times the whole river bottom was coated with green slime. Others said they had noticed that the "green gill" occurred when the leaves fell from the trees while yet green. In the present instance I examined the bottom of the river carefully and not only failed to find a coating of green slime, but failed to find the plant, even in small numbers, and the color in this case could not have come from chlorophyl bodies freed from decaying leaves, for they are different in both color and structure; but notwithstanding the fact that I failed to find a green scum on the river bottom, I was told the following summer that it was there and had been the cause of the "green gill." The plant is, I believe, a single-celled blue-green alga, which finds very favorable conditions for its growth in the gills of the oyster. The species I have not been able to determine. The affected oysters were used frequently on the *Fish Hawk* and, aside from their color, could not be distinguished from oysters not so affected.

THE SPAWNING SEASON OF BEAUFORT OYSTERS.

During the whole of the time occupied in the survey of Newport River in 1899 the oysters from the natural beds contained mature eggs and sperms in their gonads, although the number of eggs that could be taken from an individual female was not large. In North River females with mature eggs were taken until early winter, December 18 being the latest date on which artificial fertilization was successfully accomplished, but the gonads were very small, absorption having begun in October. The fact that mature eggs and sperms were present in the reproductive organs of some of the oysters at this late date does not mean that spawning continued to take place; and had they been discharged into the water their development would doubtless have been prevented by the cold.

The earliest date during the season (1900) at which eggs were successfully fertilized was the 16th of April. The oysters found at this time with mature sexual product were few, but their reproductive organs were being rapidly developed, and on May 2 nearly every oyster taken from the natural beds was ready to spawn. While it was possible to get mature eggs from the middle of April to the middle of December, the actual spawning season probably does not begin before the 1st of May, and it probably ends in November, although young oysters have been known to attach to shells in May, June,

July, August, and September, and doubtless would have attached in October and November had shells been planted during these months. Spawning takes place most actively during June and July. The gonads during this period are very large and contain the reproductive elements by millions.

SURVEY OF PAMLICO SOUND.

The commercial importance of Pamlico Sound as an oyster producing region has been recognized only since about the year 1889. Previous to that time the oysters produced in Chesapeake Bay and farther north were so plentiful and the price so low that it was not thought profitable to handle the North Carolina stock. In 1889, however, owing to the scarcity of oysters in Chesapeake Bay, the Baltimore canners and dealers in raw oysters established branch houses at various points on the North Carolina tide-water coasts, shipping their stock to Baltimore, where it was sold as Chesapeake oysters. This had a very marked influence on the North Carolina oyster industry, for with the canneries came the Chesapeake oystermen, introducing modern methods of oystering. The short-handled, wooden-headed tongs, which were at that time the only implements used by the native oystermen, were replaced by the more efficient tongs with iron heads and long handles. Of more importance still, dredging was introduced, and it has been through the dredgers mainly that the industry has been developed. Before they began operations beds located farther than 2 miles from shore were practically unknown, but now such off-shore grounds are the principal source of the Pamlico product. The following data, furnished by Mr. Stevenson, show the fluctuations in the industry since 1887:

In 1887 the yield of oysters was about 100,000 bushels for the State, and this amount had seldom been exceeded. In 1890 the North Carolina oystermen alone sold 914,130 bushels. No record was kept of the amount dredged by vessels hailing from Maryland, Virginia, Delaware, and New Jersey (about 250 in number) during the same year, but it was probably not less than 1,800,000 bushels, a single one of these vessls having been reported as taking 20,000 bushels. This rich harvest for the more experienced nonresident oystermen led to the enactment of laws preventing nonresidents from dredging and limiting the season when dredging could be carried on at all. The result was a very great decrease in the catch during the years immediately following, 60,000 bushels being the total amount reported in 1893–94 and 40,000 bushels in 1896–97.

The season during which dredging could be carried on was lengthened in 1897, with the effect of increasing the catch that year to 858,818 bushels. In 1898–99 dredging and tonging were carried on extensively from the beginning to the end of the open season (December 1 to May 1); 115 dredge boats, aggregating 990 tons and employing 750

WINDROWS OF SHELLS AND SAND ON THE MARSHY SHORE AT SHELL POINT, HYDE COUNTY.

MUSSELED OYSTERS FROM SWAN QUARTER BAY.

men, and 950 tong boats were engaged, and more oysters were caught than ever before in the history of the North Carolina industry. Many new and extensive beds were discovered, and the supply of oysters seemed to be inexhaustible; 2,450,000 bushels were taken, 900,000 of which represented the catch of the tongers.

Increased preparations were made for the season of 1899–1900, but instead of conditions such as had existed the previous year, it was found that oysters were very scarce and difficult to dredge, and only those oystermen who had had considerable experience were able to make a profit. The total catch during the entire season was about 1,900,000 bushels, of which the tongers caught nearly half. On the beds where a dredger could take 400 to 800 tubs of oysters per day during the season of 1898–99, the same men with the same equipment in December, 1900, could average but about 50 to 100 tubs.

The oystermen had different ideas as to the cause for the shortness of the crop, some attributing it to overfishing of the beds during the breeding season of the oyster, others claiming that the oysters had been killed by the severe storms which occurred in August and October of 1899.

At the request of Prof. J. A. Holmes, the *Fish Hawk* was ordered to the section in Pamlico Sound where the greatest damage was reported, with instructions to ascertain the exact cause or causes of the diminished catch. It was hoped that the investigation would suggest some practical means for rapidly replacing exterminated oysters.

The storms mentioned above were the most violent and destructive that have visited the coast of North Carolina for many years. In each case the wind blew chiefly from the southeast, producing very heavy seas in the wide, unbroken stretch of Pamlico Sound, which lay in its path. The huge waves broke all along the western and northern shores of the sound, but, as a glance at a map will show, the Hyde County coast was exposed to their greatest fury.

SWAN QUARTER BAY.

General conditions.—Section 16 of the Winslow survey, extending from Bluff Point on the east to Rose Bay on the west, was therefore selected for first investigation.

The survey of this section, which lasted from January 22 to February 28, was conducted in very much the same way as those of Newport and North rivers, except that in the present instance only those beds were surveyed and charted which are situated in places most exposed to the action of storms, namely, the public grounds numbered on Winslow's charts 38, 40, 41, 42, 46, and 48. Signals were erected on shore, the same sites being selected when possible as were occupied by the signals used in 1887–88 by Winslow. During the survey the *Fish Hawk* was anchored in Swan Quarter Bay, the work being

mainly done from launches. The State oyster police boat *Lillie* assisted in making the examinations of the oyster beds by towing the dredge boat *Varina* over them. Since Winslow's survey numerous extensive beds of oysters have been discovered in the deeper water of the section, and some of these also were examined.

The *Fish Hawk's* work showed that while the beds which were known and charted by Winslow have probably not been reduced in area, they have been so depleted of oysters and cultch that they yield a much smaller percentage of oysters than formerly, some of them practically nothing. The beds which have been furnishing the greater part of the oysters in more recent years are located over 2 miles from shore and have been discovered recently by the dredgers. Inquiries made by Mr. Stevenson showed that the beds now known in the section cover an area ten to twenty times that of the beds charted by Winslow, making the present area of the natural beds of Hyde County from 18,080 to 36,164 acres. Winslow gives the possible area of bottom in section 16 available and suitable for oyster culture as 38,315 acres. At present it is not possible to confirm this estimate, but determinate results are hoped for from experiments now being conducted by the State of North Carolina and the United States Fish Commission with reference to the possibilities of oyster culture, either private or public, on the various kinds of bottom and in the depths of water afforded by Pamlico Sound.

Damage by storms.—All along the marshy shore from Shell Point to Winslow's signal "Sherman" was found an unbroken line or windrow of large bleached oyster and mussel shells, the hinges of which were still intact. These, together with banks of sand, had been thrown up on the edge of the marsh land by the waves as they broke on the Shell Point oyster beds, and the same evidences of the violence of the waves were found on the beach at Bluff Point and various other exposed shores. The few hundred bushels thus thrown entirely out of the water would not, of course, have been a serious loss to the beds, but they serve to give some idea of the effect of a severe storm on a bottom composed of shifting material, and they are no doubt but an insignificant number compared to those covered by the bottom as it was torn up and carried before the storms. The oysters that were entirely covered with sand perished immediately, and those only partly sanded over eventually died. It was very common in February, when dredging, to bring up open-hinged oyster shells which still contained the body of an oyster nearly or quite dead. Such individuals were always so poor as to be hardly recognizable as oysters; their bodies were shrunken and their mantles and gills clogged with the sand and mud which had oozed in with every attempt to feed. Their stomachs were entirely empty. The presence on the oyster beds of empty shells in which the hinge was still unbroken was taken as evidence of

the recent death of the oysters, and the abundance of such shells in certain localities indicated that the rate of mortality during the period immediately preceding the survey had been very high. The greatest proportion of hinged shells to living oysters was found on the beds off Shell Point, south of Bird Island, east of Great Island, and off Juniper Point, while in sheltered places like Swan Quarter Bay and Swan Quarter Narrows the number of hinged shells was small. These facts indicate that the oystermen were right in attributing to the storms much of the damage sustained by the oyster beds.

Effects of dredging.—In 39 hauls made with dredges at various places on the public dredging ground (No. 48) which lies just off Shell Point, the average number of marketable oysters taken per haul was 4; of hinged shells also 4, while 8 and 5 were the average numbers of small oysters and spat, respectively. These figures show very strikingly the depleted condition of this ground as the result of too close dredging. The damage done by the storms is also indicated, fully 23 per cent of the oysters having been sanded.

Twenty hauls were made with the dredge on the dredging ground (No. 46) southeast of Swan Quarter Island, and showed the bed to be in much the same condition as No. 48. The oysters were much scattered, but the size of the productive area was found to be many times that shown on Winslow's chart, much growth evidently having taken place since 1888. The per cent of empty hinged shells was somewhat less than that on the Shell Point bed, the number representing about 14 per cent of the living oysters.

Public ground No. 42, which lies in the Swan Quarter Narrows and west of Great Island, is well protected from storms, and presented conditions which were much more favorable than those found on any other oyster ground. For the 72 hauls made on this bed there was an average of 165 living oysters, with only 16 empty hinged shells. Marketable oysters, small oysters, and spat averaged 46, 56, and 63 per haul, respectively. The relative amount of cullings taken with the oysters was much larger than on other beds, there being an average of 138 shells in each haul.

Twelve hauls were made on the public oyster ground in Juniper Bay (No. 41), which is so situated as not to be exposed to storms from the southeast, and the empty hinged shells taken here were only 4½ per cent of the living oysters. The average numbers of marketable oysters, small oysters, and spat brought up in the dredge were 61, 62, and 88, respectively.

On the public ground (No. 38) near Bluff Point, where 14 hauls were made, the work showed that the number of oysters smothered by the drifting sand was equal to about 11 per cent of the living oysters.

Although it is evident from this investigation that the beds of this section have been much overworked and that they are liable to con-

siderable damage by storms, it is also apparent that the oyster grounds have increased in size many fold since Winslow made the survey of 1888. This demonstrates that much of the bottom not producing oysters in 1888 was suitable and only needed to be planted with oysters and cultch in order to become productive. The same possibilities exist at the present time, and the natural extent of the oyster grounds can be greatly increased by strewing shells and oysters judiciously.

Close and indiscriminate dredging, however, has done more damage to the Pamlico oyster grounds in the past two seasons than any storms such as those of August and October, 1899, which at worst are of rare occurrence, and the effects of which are more easily and quickly remedied than the injury done by the dredgers, of which fifty could be counted from the *Fish Hawk* on the beds of section 16 in January, 1900. For the past two or three seasons these vessels have carried to the canneries everything they have taken from the beds, and, as a result, at the end of February, 1900, it was a tedious process to fill a dredge with either oysters or shells from the beds off Shell Point or in the mouth of Swan Quarter Bay, where the oysters are of the best quality and bring the best prices. No culling whatever has been done and there has been no attempt, so far as the writer is aware, to enforce the cull law, which provides for the return to the beds of all shells and small oysters at the time they are dredged. The cullings were found on the shell piles at the canneries, and it is doubtful whether a sufficient quantity of either seed oysters or cultch is left on the beds to provide the necessary means to obtain a new stock of oysters. The entire surface of the Chesapeake beds can be removed without permanent injury, for the uncovered deeper stratum of shells affords the necessary places for the attachment of spat; but the beds of Pamlico Sound differ from the natural beds in Chesapeake Bay and the North in that they are situated on the surface of the sand and have very little depth of shells.

When well strewn with shells, with here and there an adult oyster, it is a question of but two or three years until an oyster bed may be expected to be again productive, but when swept clean of everything, like the beds in section 16, the time required for it to become restocked by natural means may be as long as was required for the original growth of the beds.

Dredging, when properly done, is most beneficial to an oyster ground. It rapidly extends the area, for on every tack the dredging schooner spills oysters and shells as she sails past the edges of the bed. Another benefit is seen in the superior quality which as a rule characterizes the oysters taken from dredging grounds, as compared with those grown on unworked or tonging beds. The reason for this is probably in the fact that a dredger clears the beds of mussels to some extent. A tonger culls closely and throws back the mussels, thus leav-

A DREDGING VESSEL AT WORK, PAMLICO SOUND.

A "DREDGER," SHOWING DREDGES IN PLACE.

ing a larger proportion of them than before. The food of oysters and mussels is the same, and there can hardly be enough in the water over the beds to supply the enormous number of both these animals that live on some of the beds in section 16.

The bottom of the beds in this section, on which oysters of good shape and condition are found, and which underlies practically all of the natural beds, is invariably one of hard sand with a thin layer of soft organic sediment covering it. The oysters found on muddy bottoms are of ill shape and are usually poor. In the Beaufort region the conditions indicated that bottoms composed of hard sand are not adapted to growing oysters, but the Pamlico natural beds produce a finer grade of oysters than do the mud bottoms of section 24. A sandy bottom, however, is liable to be shifted and torn to pieces by the action of the waves unless it is located in a sheltered place or is held together by grass roots. To this fact is probably due the character of the natural reefs of Pamlico Sound, to which reference has been made. The beds are disturbed too often to give opportunity for the accumulation of a thick layer of shells.

The following table, based on observations made during January and February, 1899, gives the average density of the water at various localities in the section, and for comparison the densities in the same localities, as reported by Winslow in 1887, are reprinted. During the months of November and December, 1900, a number of observations on the density of the water were made at station 2, and the average during that period was found to be 1.0162.

Average densities of water in Swan Quarter Bay.

Station.	Location	Densities. 1899. Surface.	Densities. 1899. Bottom.	Densities. 1887.
1	Near can buoy in mouth of Swan Quarter Bay	1.0104	1.0106	1.010
2	Near spar buoy above mouth Caffee Bay	1.0091	1.0098	1.010
3	Near spar buoy opposite mouth Oyster Creek	1.0098	1.0099	1.010
4	Near spar buoy 1¼ miles south of east end Swan Quarter Island.	1.0094	1.0098	1.0103
5	Near can buoy 5 miles south of east end Swan Quarter Island	1.010	1.0107	....
6	Near can buoy 3½ miles southeast of Great Island in Swan Quarter Narrows	1.0107	1.0119	1.009
7	In Swan Quarter Narrows	1.0091	1.0095	1.0105

The currents in section 16 vary greatly, and observations show that their direction and velocity are governed almost wholly by the wind, there being little evidence of the influence of tides. The measurements taken varied from an almost imperceptible "set" to a maximum of one-half mile per hour. During the stay of the *Fish Hawk* in the section there were very few days when there was not a constant change of water taking place over the oyster beds.

The notes taken on the food resources of this section are given on page 286 and in the table, page 290. Animals that live with the

oysters and in the water in the region of Swan Quarter were carefully collected. Those which may be considered as enemies are the "drill" (*Urosalpinx cinerea*) and the mussel (*Modiola hamatus*). The drill feeds upon mollusks, but it is not sufficiently numerous to be of noticeable damage. The mussel is extremely abundant, however, and, as mentioned above, it injures the oysters wholly by its numbers, cutting off their water and food supply.

WYESOCKING BAY.

Wyesocking Bay (section 10 of the Winslow survey) is noted among the North Carolina oystermen as containing some of the best oyster grounds in Pamlico Sound. The oysters are said to be the earliest to fatten as the oyster season comes on, and to continue marketable until late in the spring. This section was therefore selected as the second place for work. From February 28 to March 17, 1900, the *Fish Hawk* was stationed near Gull Shoal off the mouth of Wyesocking Bay, but, the weather being stormy, very little work was accomplished and the survey of the section was postponed. It was resumed November 16 and completed December 14, 1900.

The conditions that prevailed during February and March were almost ideal for oyster culture. Food was extremely abundant and the density of the water over the largest and most productive beds in the section was the same as that over the best oyster grounds of the Chesapeake. In December the conditions were much changed, as will be noted in the density tables below and the food table (p. 290), but are not to be considered normal at that time, being the result of the unusual drought which prevailed in North Carolina during the summer and fall of 1900.

Densities in Wyesocking Bay.

Date.	Station 1 (anchorage).	Station 2, bed No. 26.	Station 3, bed No. 29.	Station 4, bed No. 27.
Winslow's survey, 1887	....	1.0122	1.0121	1.0125
February and March, 1900	1.0114	1.0118	1.0096	1.012
December, 1900	1.0179	1.0192	1.0185	1.0188

NOTE.—Water taken near the bottom was used as the basis in making the table. The water at the surface would be slightly fresher.

The bottom on the offshore areas is composed of hard sand covered with a layer of mud. On the beds the mud is thick with shells and shell fragments. Inshore the substratum of the beds is often of clay, and the layer of mud is thicker than on the offshore areas. In some places at the head of the bay the bottom is a very soft, deep, organic mud—the washings from the marshes.

On perfectly calm days it was often not possible to detect currents in the water at all, but when the wind was blowing, or on days following a storm, currents with a maximum velocity of nearly half a mile

per hour were noted. The slight rise and fall of the tide is not sufficient to influence the currents perceptibly.

Winslow charted 12 productive natural oyster beds in this section, which he numbered from 26 to 37, inclusive. Such of these as could be found in 1899 and 1900 were carefully examined. Those located inshore (Nos. 29 to 37) seem to have disappeared entirely, either through the action of storms or because of overfishing. The location of some of them was indicated by the presence of scattered shells and now and then an oyster, but nothing that could be called a productive natural bed was found. The offshore beds (Nos. 26, 27, and 28) were found to have been considerably reduced in area. The oysters taken from them in December by the oystermen were small, very few measuring more than 3 inches in length. These beds are abundantly furnished with shells, to which many small oysters and spat were attached.

The area of productive beds in this section has never been large and the oystermen that have frequented them are many. None of the beds is in water having a depth of 10 feet; they are therefore not open to dredging, but are set aside for the exclusive use of tongmen. There were dredge boats on the beds, however, in addition to the numerous tongers to be seen from the deck of the *Fish Hawk* in December, and this overfishing is probably responsible for the destruction of the small inshore beds and the reduction of area of the larger offshore grounds.

Mussels, which are so abundant in section 16 and which constitute the most serious obstacle to oyster culture there, are not numerous in section 10. The oysters have no natural enemies of consequence. Winslow's opinion that almost the entire bay is suitable to oyster cultuse was borne out by the observations of the *Fish Hawk*. It was very evident also that the section is at present not producing one-tenth the quantity of oysters it should produce.

OYSTER FOOD IN NORTH CAROLINA WATERS.

The methods used in studying the oyster food in the waters of North Carolina have been described on page 254, and the results of the work are given in tables on pages 267, 272, 289-90. The objects were to determine the relative value of different localities for maintaining oysters, the constituents of the food in each locality, their sources, and whether the supply is constant in quantity and quality from season to season and from year to year.

Some who have hitherto worked on this problem have stated that minute animals, as well as plant forms, constitute a considerable part of the oyster's diet. My observations, however, have not verified this, but have shown that plants alone constitute the food of North Carolina oysters. Fragments of small crustacea and the eggs of certain animals

have sometimes been found in the stomachs of the oysters, but so sparingly that they formed no appreciable part of the food.

It is the opinion of the oystermen that much of the food of the oyster comes from fresh-water sources, and they thus account for the fact that oysters thrive best in brackish water. This also I have been unable to substantiate, having found, on the contrary, that the plant forms which compose the oyster's food are produced on the bottom of the rivers and bays in which the oyster beds are located, in the brackish water over the beds, or in the salt water carried over the beds by the tide. Plants similar to those utilized by the oysters but not identical species were found in the ooze at the surface of the bottom of fresh-water streams, ponds, and marshes in the region of the oyster beds.

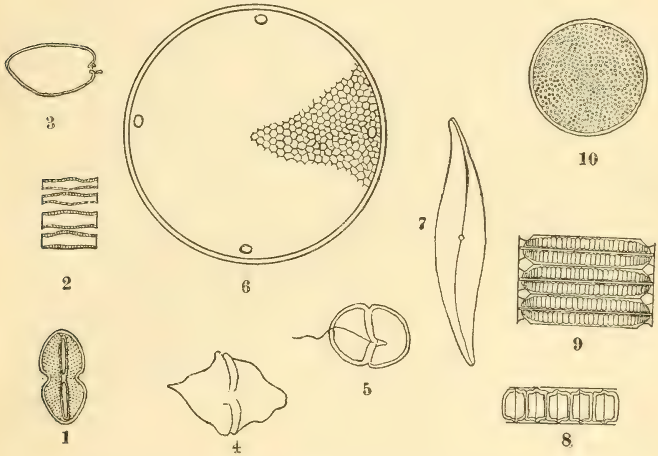
The plant forms that furnish the oyster food in North and Newport rivers are the same, though not equally abundant in the two streams. As many as 30 species of diatoms were found, from first to last, in the stomachs of the oysters, but nine-tenths of the bulk of the contents was made up of individuals of four species, figures for which are given on page 286. These species are, in the order of their abundance, *Melosira sculpta*, *Pleurosigma spencerii*, *Eupodiscusr adiatus*, and *Navicula didyma*.

Melosira sculpta is a species of diatom the individuals of which adhere end to end, thus forming filaments, which are quite brittle, however, and seldom contain more than ten individuals, the usual number being five or six. The individuals are disk shaped and have beautifully sculptured walls (fig. 9). The filaments have no motion of their own, and are hence found chiefly on or close to the bottom, except on windy days when the water is considerably roiled. The species is equally abundant in the rivers, harbor, and the open sea, and forms a considerable part of the diet of oysters everywhere in the Beaufort region. It was not found in any locality in Pamlico Sound, except near Ocracoke Inlet, which fact, taken with the above, indicates that it is a marine form.

Eupodiscus radiatus (fig. 6), is the largest diatom found in Beaufort waters. The individual plants are disk-shaped and nonmotile, but, unlike those of the preceding species, are always found singly and usually above the bottom. Owing to this position above the bottom, the reef oysters usually contain a larger proportion of these plants in their stomachs than the oysters on the beds in deeper waters, and from the fact that the diatom is more common in salt than in brackish water, the oysters on the beds near the mouths of the rivers and in the harbor get a more plentiful supply than those farther up the rivers. The species was found in Pamlico Sound near Ocracoke Inlet, but not over the beds in Swan Quarter and Wyesocking bays. Although the number of individuals found in the oysters' stomachs

or in a given quantity of water was much less than the number of individuals of the other important species, *Eupodiscus* nevertheless represented more real nutriment than they, as will be shown farther on.

Pleurosigma spencerii (fig. 7), is an S-shaped species which lives and multiplies at the surface of the mud flats of both the Beaufort and Pamlico Sound regions. It becomes especially abundant during the hot summer months and furnishes the principal part of the food of oysters in the vicinity of the flats. It is less abundant, both in the water and in the oysters' stomachs, the farther from muddy bottoms the specimens are collected, and the quantity available from



Outline drawings of the principal constituents of the food of North Carolina oysters.

1. Navicula didyma.
2. Diatoma sp?
3. Prorocentrum sp?
4. Heterocapsa sp?
5. Glĕnodinium sp?
6. Eupodiscus radiatus.
7. Pleurosigma spencerii.
8. Melosira sp?
9. Melosira sculpta.
10. Coscinodiscus perforatus.

year to year varies considerably, as may be seen by reference to the food tables on pages 289–90. The cause of this variation is not clear. In the Beaufort region the diatom was least abundant during the very wet season of 1901 and was most plentiful during the drought of 1900, yet in Wyesocking Bay just the reverse was true.

Navicula didyma (fig. 1), is 8-shaped and, like the preceding species, is motile and lives at the surface of mud flats. It is easily taken up and carried about by the water, and usually forms a very appreciable part of the diet of oysters both in the Beaufort and Pamlico Sound regions.

Among the many species of diatoms found in the stomachs of Beaufort oysters, but which have not been taken into account, either because of their minuteness or their scarcity, one may be mentioned which, after *Navicula didyma*, was next in value. It is an undetermined species of *Coscinodiscus*, and was usually present in the stomachs and in the water in greater numbers than the individuals of *Eupodiscus*. It lives above the bottom, like the latter, and has the same disk form, but it is so minute that 150 individuals would be required to make a volume equal to one *Eupodiscus*.

The relative values of the four forms considered in the tables are as follows: The volume of an individual *Eupodiscus* being 100, that of a filament of *Melosira sculpta* is 33⅓, of a *Pleurosigma* individual 10, of a *Navicula didyma* individual 3⅓.

The supply of oyster food in Pamlico Sound has not been sufficiently investigated to warrant definite statements regarding it. Two sections only have been studied, section 16, containing Swan Quarter Bay, and section 10, Wyesocking Bay, both on the Hyde County shore. Furthermore, the method of determining the amount of available food in the water was developed only during the latter part of the survey of the sound. The tables therefore show the food value of the water in but one section, Wyesocking Bay, and that for very short periods during one spring and winter. The figures given for Swan Quarter Bay were obtained after the survey of that section had been completed, from a single examination of some oysters obtained from the Swan Quarter Narrows while the survey of Wyesocking Bay was in progress. Opportunity to obtain specimens of water and oysters for further examination was not afforded. Qualitative examinations (with the microscope) had been made, however, of the contents of the stomachs of the oysters from many of the beds in section 16 and from these it was found that the food on the inshore beds, of which the beds in Swan Quarter Narrows are examples, is quite different from that on the beds in deeper water offshore, Peridineæ being much more abundant in the oysters from the Narrows. The food resources of section 16 also differed considerably from those of section 10, as may be noted from the table.

In section 10 the supply of food in March was very much richer than in November and December. The difference in amounts noted at these times may be the normal variation pertaining to the season of the year, but it was more probably due to the extreme drought of 1900, which caused the density of the water over the beds in the entire sound to rise much above its normal. The plants constituting the food of oysters in sections 10 and 16 were not found abundant in the sea or in the sections near the inlets, and it is probable that they thrive only in the very brackish water conditions which usually prevail along the western shores of the sound.

The bulk of the food supply in Wyesocking Bay consisted of eight species of plant forms—five diatoms and three Peridineæ. Several other diatoms and Peridineæ were occasionally found in the oysters' stomachs, but not in sufficient numbers to be considered important elements of their diet.

The plant that appeared most abundantly was a beautiful disk-shaped diatom, *Coscinodiscus perforatus* (fig. 10). It lived mainly in the water above the surface of the bottom and, as is evident from the table, was not so available to the oysters as the one next referred to. It was very much more abundant in the water in March than in November and December.

An undetermined species of *Melosira* (fig. 8) was the next most important constituent of food in this section, and, with one exception, it seems to be the most constant element. The individuals of this species are much smaller than those of *Melosira sculpta*, but, like the latter, they adhere end to end, forming filaments, and are found in greatest abundance near and upon the bottom.

Pleurosigma spencerii and *Navicula didyma* are the only species common to the food supply of section 10 and the Beaufort region. The former had diminished in numbers in Wyesocking Bay from March to November, but a slight increase had taken place in the quantity of the latter.

The fifth diatom present in abundance in both the oysters and water I have been unable to identify. It is an elongated form, the individuals of which lie side by side in small colonies, as I have shown roughly in figure 2 on page 285. Less difference was noted in the abundance of this species during March and November than for any other. It seemed to thrive as well in salt as in brackish water.

None of the Peridineæ could be specifically identified, but the genera to which they belonged were determined. The species of *Glenodinium* (fig. 5) was conjugating in March and, because of the large buoyant gelatinous capsules secreted about them, the individuals were quite evenly distributed through the water. Those not inclosed in capsules were not dependent upon the currents in the water for their distribution, but moved about actively. This species had almost completely disappeared in November. *Heterocapsa* (fig. 4) is found in greater abundance near the bottom than at higher levels or at the surface of the water, and is more abundant near the mainland and marshes than over beds offshore. It, too, had almost disappeared in November. The species of *Prorocentrum* (fig. 3), on the other hand, was very much more numerous in November than in March. Individuals were occasionally found in the oysters from the beds near the mouths of Newport and North rivers and in Jarrats Bay, which indicates that this form is adapted to water with a high density, such as prevails in

the places last named and as was found in Wyesocking Bay in November, 1900.

The food supply in section 16 differed very much from that in either section 10 or the Beaufort region. The inshore beds also differed considerably in this respect from those in deeper water. On the offshore beds during January and February the oysters were living chiefly on diatoms (*Melosira* sp.?, *Coscinodicus perforatus*, *Pleurosigma spencerii*, and *Navicula parva*), with a much smaller bulk of the same species of Peridineæ mentioned as having been found in section 10, but, as the table shows, the food on the inshore beds consisted mainly of Peridineæ, the water swarming with these plants.

While the oysters on some of the tonging grounds and on the unworked beds in deep water are frequently poor during the oystering season, it does not necessarily follow that the food supply is at fault, for on the beds just mentioned the oysters are not only very numerous and closely crowded, but each oyster is literally covered with mussels, the diet of which is the same as that of the oyster. One hundred mussels is not an unusual number to find attached to a single oyster on such beds, and since the water must pass the mouths of all these mussels before reaching the mouth of the oyster it is not surprising that there is not enough food for all.

Food of North Carolina Oysters.

NEWPORT RIVER—CROSS ROCK.

Date of examination.	Density of the water.	Condition of the oysters.	Food. Melosira sculpta. Oyster.	Melosira sculpta. Water.	Pleurosigma spencerii. Oyster.	Pleurosigma spencerii. Water.	Eupodiscus radiatus. Oyster.	Eupodiscus radiatus. Water.	Navicula didyma. Oyster.	Navicula didyma. Water.	Total. Oyster.	Total. Water.
Apr., 1900	1.0168	Very good	6531	1920	2964	6720	1254	960	2052	2400	12801	12000
May, 1900	....	....do	5628	4290	2520	5866	1092	5866	420	....	9660	16022
May, 1901	1.004	Good	2025	840	3136	2520	216	675	131	225	5508	4260
June, 1900	1.0171	Very good	6478	3600	27293	33120	1593	1440	....	....	35364	38160
June, 1901	1.0080	Good	3874	2102	1202	1612	686	1434	547	338	6309	5486
June, 1902	1.020	Fair	3058	1670	504	1671	106	....	24	239	3692	3580
July, 1900	1.0214	....do	5724	1864	9063	48416	106	432	159	132	15052	51141
July, 1901	1.0071	....do	2666	2842	567	3381	196	490	87	254	3516	7007
July, 1902	1.0195	....do	2915	1432	1638	27309	53	120	80	120	7686	28981
Aug., 1900	1.0208	Good	5272	1038	12804	62208	824	983	979	980	19879	65209
Aug., 1901	1.0149	Fair	2566	1470	1361	5071	195	392	152	294	7274	7227
Aug., 1902	1.0219	Good	2120	2267	12058	46985	27	....	....	358	14205	49610
Sept., 1901	1.0141	....do	3615	3691	1895	4410	65	653	65	490	5640	9241
Sept., 1902	1.0113	....do	1903	597	11862	29336	....	1193	....	....	13765	31126

NEWPORT RIVER—EXPERIMENTAL OYSTER BED.

Date of examination.	Density of the water.	Condition of the oysters.	Food. Melosira sculpta. Oyster.	Melosira sculpta. Water.	Pleurosigma spencerii. Oyster.	Pleurosigma spencerii. Water.	Eupodiscus radiatus. Oyster.	Eupodiscus radiatus. Water.	Navicula didyma. Oyster.	Navicula didyma. Water.	Total. Oyster.	Total. Water.
Apr., 1900	1.0168	No oysters on bed.	....	....	....	....	....	....	....	....	....	....
May, 1900	1.0172	Very good	10656	10296	2736	2876	864	2376	1008	....	15264	15548
May, 1901	1.0062	Good	6908	1168	1884	2016	314	168	....	....	9106	3352
June, 1900	1.0179	Very good	9273	7351	62000	21428	2584	1303	627	535	71484	30617
June, 1901	1.0069	Fair	3642	2879	511	2409	209	529	392	352	4754	6169
June, 1902	1.0205	Good	5910	1789	875	2029	133	120	136	120	7051	4058
July, 1900	1.0212	Fair	3324	2169	5846	9418	831	1385	277	174	10278	13546
July, 1901	1.0078	Poor	1676	2646	196	3416	131	588	87	294	2090	6944
July, 1902	1.0210	Fair	3599	1312	2597	4413	....	358	133	....	6329	6083
Aug., 1900	1.0216	....do	3636	7701	2526	2996	202	1284	505	428	6869	12412
Aug., 1901	1.0156	....do	5030	2572	1960	4679	208	759	231	294	7429	8301
Aug., 1902	1.0213	....do	1193	2028	7503	22181	27	....	27	....	8750	24209
Sept., 1901	1.0151	Good	5604	8741	1022	3972	294	1552	87	745	7007	15010
Sept., 1902	1.0180	Fair	1140	418	4399	14053	27	478	159	120	5725	15069

Food of North Carolina Oysters—Continued.

NORTH RIVER—EXPERIMENTAL OYSTER BED.

Date of examination.	Density of the water.	Condition of the oysters.	Food. Melosira sculpta.		Pleurosigma spencerii.		Eupodiscus radiatus.		Navicula didyma.		Total.	
			Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.
April, 1900	1.0164	Good	10079	5012	1011	6264	4831	3759	7765	3758	23686	18793
May, 1900	1.0198	Fair	4410	4109	1621	5993	1285	1992	2583	1409	9899	13503
May, 1901	1.0100	Very poor	1307	1638	327	1176	523	378	1241	1050	3398	4242
June, 1900	1.0212	Poor	3298	1383	970	2671	388	1653	1552	387	6208	6094
June, 1901	1.0114	Very poor	1084	1249	152	882	174	514	611	1102	2021	3747
June 1902	1.0220	do	1113	955	159	1436	53	120	265	478	1590	2989
July, 1900	1.0234	Poor	3744	1728	2448	576	576	1495	720	919	7488	4718
July, 1901	1.0111	Very poor	864	784	109	980	87	490	218	392	1278	2646
July, 1902	1.0228	Poor	2915	2624	27	1312	159	239	239	358	3340	4533
Aug., 1901	1.0154	Fair	2156	1764	1093	3748	245	808	621	294	4015	6604
Aug., 1902	1.0230	Very poor	1742	1231	318	3459	159	120	239	....	2458	4810
Sept., 1901	1.0168	Fair	5586	3048	2949	4233	457	500	544	588	9536	8769
Sept., 1902	1.0211	Poor	2121	2505	6569	15980	80	....	529	88	9299	18573

PAMLICO SOUND—WYESOCKING BAY.

Date of examination.	Density of the water.	Condition of the oysters.	Food. Melosira sp. —?		Pleurogigma spencerii.		Coscinodiscus perforatus.		Navicula didyma.		(?)		Prorocentrum sp. —?		Heterocapsa sp. —?		Glenodinium sp. —?	
			Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.	Oyster.	Water.
Mar., 1900	1.011	Very good	4343	1029	2635	9187	6565	25892	14	114	1946	2572	144	....	2590	1423	1703	5722
Dec., 1900	1.018	Fair	3676	2011	483	742	3463	5583	159	141	1899	2364	2123	1766	....	....	....	....

PAMLICO SOUND—SWAN QUARTER NARROWS.

Mar., 1900	1.0078	Fair	578	....	....	....	....	....	a 289	....	....	....	....	....	20253	....	7667	....

a Navicula parca.

RATE OF FEEDING.

Some experiments were made during the summers of 1900 and 1902, in order to ascertain the rapidity with which a Newport River oyster is able to collect the amount of food usually found in its stomach, and the methods and results of these experiments are given in the text and tables following.

A number of oysters were tonged from one of the Newport River natural oyster beds, and individuals of about equal size (about 3½ inches in length) were selected for the experiments. Three of them were immediately opened and their stomach contents removed and preserved. The others were taken to the laboratory, scrubbed clean, and put to fast for three days, in order to rid them, without injury, of the food already in their stomachs. Twice each day they were put into a tub filled with filtered sea water, so they might throw out any refuse matter which had collected and be kept in a healthy condition. It had previously been noted that digestion is not carried on normally while the animals are out of the water, and the object of these baths was mainly to stimulate the normal process of digestion and to rid the stomachs of diatoms as quickly as possible. On the fourth day three of the oysters were opened and the stomach contents then remaining were removed. This amount was made the basis for the calculations of the rate of feeding. The remaining oysters were taken back to their home feeding ground and placed in the water near a stake. At convenient intervals they were taken up (three each time), opened, and the contents of their stomachs removed. The tables show the dates when the experiments were made and the amount of food found at each examination of the stomach contents. A table is also given showing the averages calculated from the results of all the experiments. From these figures it appears that each oyster collected 385 diatoms during the first hour, 550 during the second, 1,406 during the third, and 4,301 during the fourth. This increasing rate of feeding is probably to be explained as due to gradual recovery on the part of the oysters from the shock of their unusual treatment in the laboratory. The rate at which feeding took place during the fourth hour is probably much nearer the rate at which it occurs with oysters living undisturbed on the beds.

The work on the food resources of Newport River shows the average number of diatoms per liter (or about a quart) available to the oysters on the natural beds during the summers of 1900, 1901, and 1902 to be 23,432, and that the oysters of salable size examined during this time contained, on an average, 11,453 diatoms. If the usual rate of feeding under natural conditions is near the figures obtained from the above experiments, 4,301 diatoms per hour, then three hours is ample feeding time for an oyster; and taking 23,432 as the average amount

of food contained in each liter of the water over the natural oyster grounds, it follows that in collecting its daily meal (11,453 diatoms) an oyster must filter altogether about 500 c. c., or 16 ounces, of water, and that about 167 c. c., or 5⅓ ounces, are filtered per hour. The length of the feeding time in any locality very probably depends upon the richness of the supply of food in the water, the time of feeding becoming longer as the food supply diminishes in quantity. Not until the supply of food falls below an amount one-eighth of that found in Newport River would it fail to support oysters. The "coon" oysters on the tops of the high reefs, although exposed to the air for several hours each day, are in no danger of starvation so long as they are covered by the tide for a few hours each time, and so long as the food supply retains its present richness.

Results of experiments to determine rate of feeding.

Date.	Time of examination.	Stomach contents.				
		Melosira sculpta.	Pleurosigma spencerii.	Eupodiscus radiatus.	Navicula didyma.	Total.
1900.						
July 31	When taken from bed	3,318	5,846	316	474	9,954
Aug. 4	After fasting 4 days	198	79			277
Do	After feeding 2 hours	302	403	101		806
Do	After feeding 3½ hours	1,512	532	208	108	2,360
Aug. 6	When taken from bed	3,193	4,372	326	615	8,506
Aug. 9	After fasting 3 days	675	75			750
Do	After feeding 2 hours	990	180	90		1,260
Do	After feeding 4 hours	1,820	280	560	140	2,800
1902.						
Aug. 19	When taken from bed	636	3,551	53		4,240
Aug. 22	After fasting 3 days		53			53
Do	After feeding 1 hour	53	987			1,040
Do	After feeding 2 hours	106	530	53	53	742
Do	After feeding 3 hours	265	2,809			3,074
Do	After feeding 4 hours	689	10,494		53	11,236
Sept. 1	When taken from bed	1,216	5,300	53		6,569
Sept. 4	After fasting 3 days	159	265			424
Do	After feeding 1 hour	121	362			483
Do	After feeding 2 hours	360	1,982		90	2,432

Average calculated from the above.

Condition of oysters.	Stomach contents.				
	Melosira sculpta.	Pleurosigma spencerii.	Eupodiscus radiatus.	Navicula didyma.	Total.
When taken from bed	2,091	4,767	187	272	7,317
After fasting	258	118			376
After feeding 1 hour	87	674			761
After feeding 2 hours	440	774	61	36	1,311
After feeding 3 hours	888	1,671	104	54	2,717
After feeding 4 hours	1,254	5,387	280	97	7,018

CONCLUSIONS BASED UPON THE WORK OF THE SURVEY.

Productive natural oyster beds in Newport and North rivers are confined to the upper waters, and have been materially reduced in area since 1887, the reduction caused by overfishing to supply the oyster canneries at Beaufort. In Pamlico Sound the decrease in productiveness of the natural grounds since that date is still more marked, many of the then extensive beds being almost entirely depleted, and the fact that this region continues season after season to yield a considerable quantity of oysters should not lead to the supposition that the supply is inexhaustible. The survey of sections 10 and 16 showed that the oystermen have discovered many new grounds to which they could turn when the older ones ceased to be productive, but the number of unknown grounds is not unlimited, and in the near future new beds will no longer be discoverable. Now is the time to apply the remedy, and in order to check the destruction of the natural beds in Pamlico Sound either a cull law should be enforced or shells from the canneries and raw houses should be returned to the beds annually during the months of May and June, carefully and evenly scattered over the depleted areas, about 2,000 bushels per acre.

The physical and biological conditions existing in Newport and North rivers are very favorable to the growth of young oysters, but are not so well suited to the production of large marketable stock. The supply of available oyster food is abundant and has been fairly constant during three seasons. The currents in the water are such as to insure a good circulation of pure water over the beds and a constant supply of food to each oyster. The amount of lime salts in the water is also adequate to their needs. On the other hand, the density is usually too high and the bottom outside the natural beds is too soft.

The conditions in Pamlico Sound are very different from those in section 24, and, on the whole, are better adapted to the production of oysters. There are extensive areas where the density of the water is perfectly suited to the needs of the animal. The currents are a trifle too sluggish, and there are times during very calm weather when the circulation over the beds is not as rapid as is desirable, but food is very abundant and the bottom has the necessary firmness, though it is mainly composed of sand, and in exposed areas is likely to be shifted during high winds.

Oyster planting has been unsuccessful both in section 24 and in Pamlico Sound. The failures, however, have not been due to insurmountable difficulties existing in the various localities, but to lack of experience on the part of the planters or to a belief that an experience in planting oysters in the North is an adequate preparation for planting in an entirely different section of the country where the conditions are very different. Each oyster-producing section has an oyster question of its own entirely separate from that of other localities, and a

failure to recognize this fact is likely to lead to failure in any attempt to grow oysters. There is no one oyster question, but there are many oyster questions.

In order to encourage an industry in oyster planting in North Carolina, certain areas in localities which are known to be or to have been productive of oysters should be set aside for the use of planters, and provision should be made to guarantee their rights effectively.

OYSTER-PLANTING EXPERIMENTS IN NEWPORT AND NORTH RIVERS.

The "oyster gardens" of the North Carolina coast date back to the year 1840, but, as before stated, they were used mainly as places for bedding oysters for family use, no attempt being made to carry on an industry for commercial purposes. The years immediately preceding and following the oyster survey by Winslow in 1886–1888 and the completion of the railroad from Wilmington to Jacksonville in 1890 witnessed the greatest enthusiasm in oyster planting in North Carolina. Hundreds of acres of bottom were taken up during this period and thousands of bushels of oysters were planted. In very few cases, however, were the results such as to encourage the continuation of the operations already begun or the beginning of new ones. A revival of the interest took place in Carteret County in 1896 as the result of the success of some of the plants made in North River and Jarrats Bay in 1891, and many entries of ground were again made and considerable planting done, but in 1899 there was not a single oyster bed anywhere in North Carolina, so far as I have been able to ascertain, which was being cultivated or which was yielding or had yielded its owner an income in anyway commensurate with the labor and expense put upon it. It seemed that the industry had been given a fair trial, had proved a failure, and was now a thing of the past, so far as North Carolina was concerned.

The failure is much more apparent than real, however, from a statistical point of view, for of the very large number of entries of ground made for the avowed purpose of oyster planting comparatively few were ever so used. In most cases the ground was entered as a speculation, the purpose of the owner being to hold it until a profitable industry in oyster planting should be developed. The improvements put upon such beds consisted usually in nothing more than setting boundary stakes. The existing adverse opinion of the waters of North Carolina as a field for oyster culture therefore rests upon a very questionable foundation, since in the sum total of complete failures such beds as those just mentioned form a very considerable part.

To many of the public-spirited men of the State the outcome of the enterprise was very disappointing. There seemed to them no reason why the waters of North Carolina should not be as well adapted to

oyster culture as those of the North Atlantic States, and not until the question had been thoroughly investigated were they willing to allow the subject to be dropped and the effort given up. It was therefore decided, in addition to a general study of the conditions prevailing on both natural and planted beds, to begin some experiments in Beaufort waters, various methods of preparing the bottom to be tried before planting the oysters. Accordingly, when the steamer *Fish Hawk* left Pamlico Sound in March, 1900, the writer was directed to go to Beaufort, get together an equipment suitable for the work of planting shells and oysters, and begin operations. The outfit secured was such as is owned by the local oystermen and fishermen—namely, a small one-mast sharpy, skiff, oyster tongs, shovels, buckets, and an ax. One laborer was hired to assist in the work.

Recent experiments.—In selecting grounds for the planting experiments care was taken that they should include no natural oyster beds. Two beds were surveyed and marked with stakes before the *Fish Hawk* left the Beaufort region—one in Newport River, containing 5 acres, the other in North River, containing 10. On the Newport bed, situated just above the mouth of Harlow Creek (see map), the bottom has all the conditions to be found on the entire river bottoms, from hard white sand to very soft deep mud. The depth of water over it varies, at low tide, from $1\frac{1}{2}$ to 4 feet. The currents are tidal in origin and at this point in the river they sometimes attain a velocity of nearly three-fourths of a mile per hour. The North River experimental bed is situated off the mouth of Roberts Bay and on the east joins the oyster garden belonging to Mr. M. E. Piver. The bottom is composed wholly of deep, soft mud. At low tide the water over it is from $3\frac{1}{2}$ to 5 feet in depth. As in Newport, the currents in North River are mainly tidal, and for some time before low or high water a velocity of one-third of a mile per hour is reached in the vicinity of the bed. In order that the experiments in both rivers should be conducted on bottoms of different kinds, Mr. Elias Piver very kindly allowed us to make use of the hard sandy part of his garden, on which one planting was made.

As far as was possible the work in these rivers was carried on in the same way, each planting in the one being duplicated in the other. It was the intention to take the temperature of the water as regularly as the density, but this was neglected so often, the thermometer being in use elsewhere, that the records are too incomplete to be of much value. During the months of June, July, August, and September, when low water occurred during the middle part of the day, the temperature over the beds often rose as high as 90° F., but the usual summer temperature is about 80°. During the winter months ice often forms over the beds.

The climatic conditions which prevailed during the three years cov-

ered by the experiments were fortunately very different. The first season was very dry, especially the latter part. From April to September the average density of the water over the Newport bed was 1.0189; over the North River bed, 1.0202. The second season was very wet, the effect of the fresh water being noticeable even to Beaufort Inlet. From May until September the average density was 1.0103 and 1.0129 in Newport and North rivers, respectively. During the season of 1902, from June until September, the average density over the Newport bed was 1.0202; over the North River bed it was 1.0224. From the last figures it would appear that a greater drought prevailed in the vicinity of Beaufort in 1902 than in 1900, but this is explained by the fact that the work in 1900 covered the months of April and May, when the effects of the spring rains were yet noticeable, while in 1902 the work began with June, when the fresh water which had fallen in the spring had become well drained off. The density for each month is given in the food tables on pages 289–90.

It having been ascertained that Newport and North River oysters are in spawning condition as early as March and continue to spawn until late in December (see page 275), it was decided that plantings should be made in the spring, summer, and fall, in the hope thus to find the most favorable time for exposing spat collectors. Expensive and time-consuming methods of planting were avoided as wholly impracticable for the North Carolina oyster industry. In Europe, where large single oysters often sell for 5 cents each, it is possible to construct expensive claires for fattening the oysters, to expose tiles coated with a layer of lime for collecting spat, to take up the exposed tiles and painstakingly scale off the small oysters, to plant these in baskets constructed especially for this purpose, and to variously elaborate the methods of culture; but in North Carolina, where the price is frequently as low as 15 cents per bushel and seldom reaches a price higher than 45 cents per bushel, such refined processes are out of the question.

The liberation of artificially fertilized oyster eggs in the water has been suggested as a method of increasing the number of oyster fry in certain localities, but after repeated trials it has not proved successful, and no attempt was made to follow it here. In North Carolina the operation is expensive, not only from a practical dollars-and-cents standpoint, but from the biological point of view as well. Fully one-third of the eggs that can be taken at any one time from a spawning female oyster are unripe, are therefore incapable of fertilization, and are lost. Moreover, in taking the eggs and sperms the adults are sacrificed; and practice has shown that the young oysters that develop from eggs confined in hatching dishes or troughs all die before they attain the settling or attaching stage, probably from lack of proper food. Young attached oysters have never been procured from eggs

so kept. Doubtless if, instead of keeping the eggs in hatching dishes for any considerable time after they have been fertilized, they should be deposited in the water near the place where it is desired to establish a bed, they would pass through their development normally, provided they did not encounter adverse climatic conditions, such as a cold rain. This has been found to be fatal to free-swimming oyster fry. In order that the fry resulting from the deposited eggs shall be secured in the desired localities, it is necessary that the tides and river currents be such that the free-swimming oysters shall be carried over the exposed cultch at just the time when they are ready to settle and become attached, and as it is not possible to calculate when the attaching stage will be reached, the chances are that none of any one lot will fix themselves to cultch exposed to receive them.

If, on the other hand, the oysters are allowed to remain in the water and spawn normally, the least amount of loss of spawn takes place, and there is the greatest possible chance of securing a proportion of the resulting young oysters. So many spawning oysters live together on a bed that the chances of a failure of ripe eggs to meet with sperms are few. The spawning of an individual oyster probably covers a considerable period of time (six to ten weeks), the reproductive elements being given out a few at a time as they mature. In this way none are lost, but every egg has a chance to develop, and during the breeding season there is probably not a time when there is not present in the water in every locality in the vicinity of oyster beds a considerable number of fry in all stages of development. Thus a bed may be established at any desired point by simply exposing the proper cultch in the proper way.

Spawning oysters may be deposited in localities where natural beds are wanting, but in North Carolina the reefs furnish an abundant supply of spawn. My experiments have shown that there is no difficulty in securing a good set of spat on planted shells; in fact, the difficulties seem to lie in the other direction—in limiting the number which may be secured. The work undertaken, therefore, aimed at a simple method of utilizing the supply of fry already present in the water.

Since oyster shells are available in immense quantities at very little cost at many points on the North Carolina coast, they were used in the experiments not only as spat collectors but for hardening the bottoms of such beds as were to receive the seed oysters. Many of the Beaufort oystermen who professed to have had experience in shell planting advised against the use of steamed shells, giving as their reason that young oysters will not attach to shells which have passed through the steaming process. After exposing both raw opened and steamed shells to the same conditions, however, I have not found that oyster spat have any preference.

In addition to shells, bundles of pine brush were tried as spat col-

lectors, but in this case without success. Had the experiments with the brush been repeated with slight modifications, however, more favorable results might have been obtained, for Winslow records cases in which oysters in great numbers attached to and grew upon brush thrown into the water, and in parts of Europe this method of collecting spat is extensively used.

Since the object of the experiments in oyster planting was not to produce oysters for commercial purposes, but to demonstrate that they may be grown on muddy bottoms and to develop methods by which such planting can be done successfully, no large beds were made, but numerous small areas were planted and various methods employed. The results obtained from a small planting are just as valuable for the purpose in hand as if they were obtained from plantings covering acres.

Before an area was planted with shells or oysters it was marked off with stakes and the bottom examined either with a sounding rod or by wading about over it. The sharpy in which the shells and oysters were brought to the beds was then anchored over the area to be planted, and held in position by poles thrust into the bottom, one on either side. The planting was done from the stern either by throwing the shells or oysters broadcast from the deck or, when the shells were planted in rows, by standing in the water and receiving the shells in buckets, to dump them along a line stretched between stakes.

The shells and oysters on each of the areas were carefully examined at intervals of about six months and the results of each examination tabulated. In examining for spat and larger oysters, the following methods were used: A quantity of shells was tonged from different parts of the area, and one bucketful was taken to the laboratory for examination. These were chosen at random—that is, without reference to whether they contained spat or not, it being desired that they represent as well as possible the condition of the bed. One hundred of these shells were carefully gone over in the laboratory, and the numbers of living and dead oysters noted. The living oysters were divided into five classes: (1) Spat (meaning by this term a young oyster less than one-half inch in length); (2) oysters between one-half and 1 inch in length; (3) oysters between 1 and 2 inches long; (4) oysters between 2 and 3 inches long, and (5) oysters more than 3 inches long. When it was possible to tell the cause of death, this was noted. The number of oysters attached to the inside of the shells was kept separate from the number attached to the outer surface.

The method of ascertaining the results of planting seed oysters was to tong 100 from the bed, noting how many of this number were still living, their general condition, and the amount of growth that had taken place. During the first two seasons it was comparatively easy to distinguish the shells of planted oysters that had died from the

planted shells, but not so easy during the third. Neither was it possible during the third season to distinguish the living seed oysters from the oysters grown on the beds.

The location of the experimental oyster beds is shown on the large charts of Newport and North rivers, and the location of each of the planted areas is given on the smaller charts of the experimental beds (pages 300–301). A condensed history of each of the 31 planted areas, from the date of planting to the end of the third season, is given in a table on pages 306–309. To write a detailed account of each planting in addition to this table would be to multiply words uselessly, since in many cases the methods used and the results obtained were practically the same. A few detailed descriptions of certain typical areas, however, will be necessary to give an idea of the work done and its results.

DETAILED ACCOUNTS OF CERTAIN PLANTING OPERATIONS.

Area No. 1.—The first planting was made April 26, 1900, with 41 bushels of shells arranged in five rows across the current. This 570 square feet of stiff deep mud, into which an oar can be thrust to a depth of 15 inches, is covered at low tide with 3½ feet of water. During the first summer an immense number of spat attached to the shells, many of which on the 6th of August measured nearly two inches in length. The number dead or killed during the first season was also large, being about two-fifths of the total number that attached to the shells. Of those found dead on August 6, about three-fifths were smothered by mud and the remainder were killed by "drills" (*Urosalpinx cinerea*), as was shown by the small round hole in the shells. The number of living oysters found on June 3, 1901, was a little less than half the number present at the time of the previous examination. Very few were larger than those found on August 6, so that either little growth had taken place or the first catch had practically all died and a new lot had become attached. During June and July, a rapid growth took place and an enormous number of additional spat were caught; but toward the end of July and the first of August every oyster died. On August 18, when the regular examination was made, 640 dead oysters were counted on 100 shells, many of them with the hinge of their shells intact. The planted shells had settled quite deep into the mud, and this may have been a partial cause of death; but from the fact that all died at about the same time, and that during July the parasitic worm (*Bucephalus cuculus*) already referred to had infested them in great numbers, I am inclined to believe that the parasite is accountable for much of the loss. No spat attached to the shells after this time; at least, none was found on those examined September 12, 1902.

Area No. 2.—This planting was made on the same day as No. 1, but in this case the bottom was composed of hard white sand, covered by

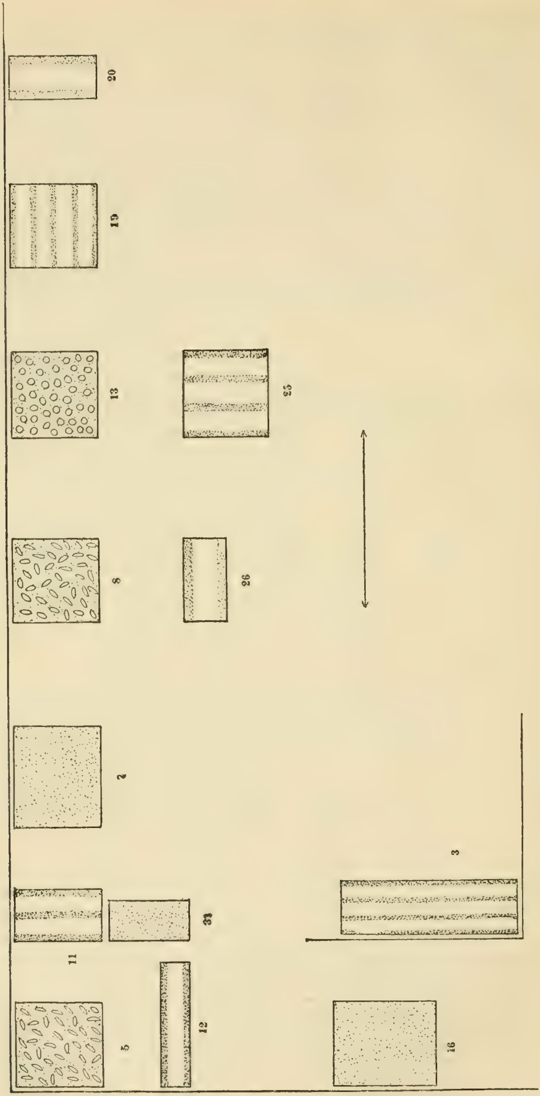


Chart of experimental oyster bed in North River, showing the planted areas, method of planting, etc.

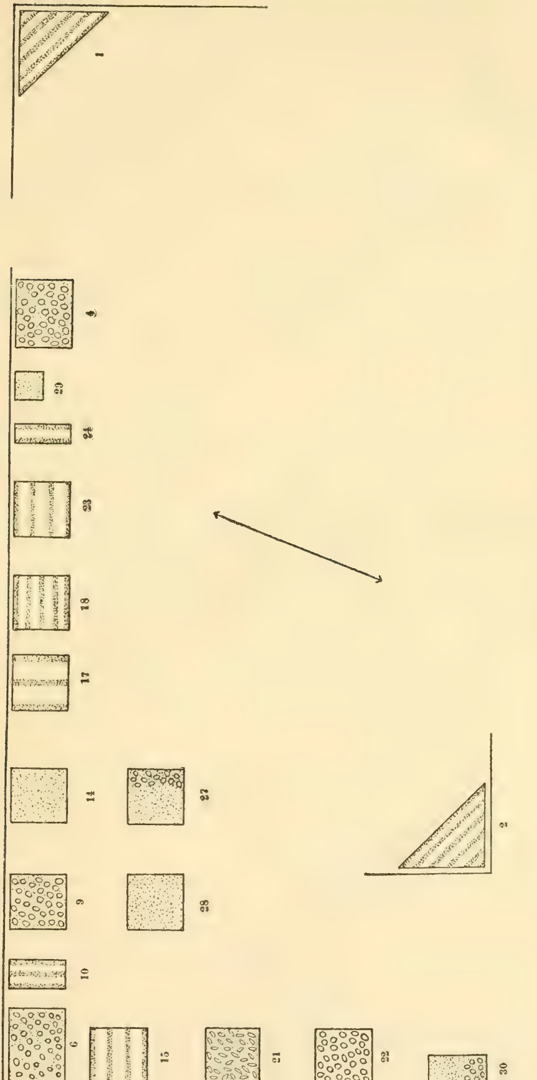


Chart of experimental oyster bed in Newport River, showing the planted areas, method of planting, etc.

about $1\frac{1}{2}$ feet of water. Forty bushels of shells were planted in five rows across the current. During the first summer a considerable quantity of spat became attached to the shells, but soon died, owing probably to the presence of sand grains inside their shells. In rough weather the sand shifted readily, and by the end of the second summer the planted shells were all covered.

Area No. 3.—The third planting was made in North River on April 27, 1900, on the southeast corner of Mr. Piver's oyster "garden," which, at this end, is composed of hard white sand. The depth of the water is about 4 feet at low tide. Seventy bushels of shells were planted in four rows across the current on an area covering 750 square feet. This bed has a history similar to that of No. 2, considerable quantities of spat being caught during the first season, but killed by the sand, which entirely covered the planted shells before the end of August, 1901.

Area No. 4.—The ground selected for this planting, which was made May 5, 1900, was in Newport River on deep, sticky mud, covering an area of 500 square feet. Sixty-three bushels of shells were scattered over it as evenly as possible, making a layer $2\frac{1}{2}$ shells in thickness. To this were added on May 16, 1900, 18 bushels of the best oysters that could be gathered at low tide from the edges of the reefs in Core Creek. This stock was composed of oysters of fairly good shape, but varying from $2\frac{1}{2}$ to 4 inches in length. They were planted on the same day they were gathered, in an even layer over the shells, the average number to each square foot being about 18. These oysters have had the best history of any that were planted so far as the number that lived is concerned, as will be seen by reference to the table on page 306. They made little growth, however, the edges of their shells becoming thick and blunt.

Area No. 5.—Planting was begun on this area May 8, 1900, by broadcasting it with 70 bushels of shells, and was continued May 11, 1900, by adding 18 bushels of seed oysters. The location is in the southwest corner of the North River bed and contains 400 square feet of soft mud, into which it is possible to thrust an oar to a depth of 3 feet. The depth of the water varies from $3\frac{1}{2}$ to 6 feet. The shells were scattered over the bottom, giving it a hard surface $3\frac{1}{2}$ shells in thickness. The seed oysters were "coons" picked up from the reefs at Howlands Point, and many of them were in small clusters. They lived well during the first season, but many died during the following winter and spring, 20 per cent only being left on May 30, 1901. On September 9, 1902, none were found, although a considerable number of the spat grown on the bed were doing well. Little or no improvement in the shape of the seed oysters was noted. The transplanted oysters were taken from a locality where the water is usually very salt to one in which the density is much lower.

Area No. 6.—On May 14, 1900, the sixth planting was made in Newport River, on 500 square feet of sticky mud, in from 3 to 5 feet of water. Eighty bushels of shells were evenly distributed, giving the bottom a coat $3\frac{1}{2}$ shells in thickness. On the following day 18 bushels of the best single oysters that could be gathered from the edges of the Cross Rock beds were scattered upon the shells. During the first season very little growth took place among the seed oysters, but in 1901 they grew rapidly, though not so rapidly as the oysters that attached to the planted shells, for it was not always possible during the third year to distinguish the oysters that had been planted from those grown on the bed. During the summer of 1900 the planted shells became the home of an abundance of animals of different kinds, including ascidians, anemones, leptogordias, sponges, and bryozoa, but these were all killed by the fresh water in 1901. Since then the beds have been comparatively free from all animals, excepting barnacles and a few species of snail which are always common on the oyster beds in this locality.

Although nearly half of the planted oysters were dead on August 17, 1900, and the number of spat that attached to the shells was never very great, the bed was well stocked in 1902 with large oysters of fairly good shape, many of which were used in the Beaufort laboratory.

Area No. 9.—This area of soft mud in Newport River, containing 400 square feet, was planted May 31, 1900, with 50 bushels of shells, distributed over the surface as evenly as possible in a layer $2\frac{1}{2}$ shells in thickness. On June 12, 1900, there were added 15 bushels of good oysters tonged from the Cross Rock beds. These oysters, everything considered, have had the best history of all the plants made. The per cent living at the end of the second season was not quite so high as in two other cases, but a more rapid growth took place. On many of the beds the planted oysters became blunt and thick-shelled, but the shells of these were thin and showed rapid growth. The spat that attached to the planted shells grew rapidly also, and the oysters were well shaped. During the third season they had attained the size of the planted oysters, from which they could not be distinguished. While no careful examination of the beds was made in 1903, this one was frequently visited, and bushel after bushel of fine oysters removed from it.

Area No. 13.—The description of this area is given here for better comparison with the one just described. It includes 400 square feet of very soft muddy bottom in North River, which on June 21, 1900, was evenly covered with a layer of shells 3 shells in thickness, 63 bushels being planted. Four days later 15 bushels of finely shaped oysters, tonged from the Cross Rock beds in Newport River, were distributed over the shells. It will be noted that the stock for this planting was the same as that planted on area No. 9, in Newport River,

and that the oysters were planted at about the same time and upon similar bottoms. The results of the two plants, however, are very different. Ten per cent only of those planted in North River were living at the end of the second season, little or no growth having taken place, while 68 per cent of those planted in Newport River were growing nicely when the examination was made in September, 1902. The difference in the food supply on the two beds was not great enough to account for the difference in result, as will be seen by reference to the tables on pages 289–90. The principal difference in the conditions was that in the first instance the oysters were transplanted to a locality in which the density is not usually much higher than that over their native rock, while in the second a considerable change was experienced in this respect, the North River experimental bed usually being covered with water having a much higher density than the Cross Rock beds.

Area No. 12.—The twelfth planting was made in North River June 13, 1900, with 60 bushels of shells in two rows parallel to the currents. The area is small, covering but 200 square feet. As was usual with shells planted in rows, either parallel or at right angles to the flow of the currents, large numbers of spat became attached and the oysters showed rapid growth, but as they grew larger there was a tendency to become long and narrow. The spat becomes attached principally to the shells at the tops of the ridges, as these offer the cleanest surfaces and the most favorable feeding conditions. Those on the sides of the ridges and at the bottom soon become coated with sediment. The conditions on the tops of the ridges are in reality too well suited to the needs of the oyster fry; too many spat usually become attached, so that as they increase in size they interfere with each other, becoming "coony" as the result. This method of planting might be used to advantage in localities where oyster fry are scarce or in cases in which the shells are to be transplanted not later than one year from the time when they were first exposed.

Area No. 22.—This area in Newport River was the last planted in 1900. No shells were put out, but on July 20 10 bushels of small but nicely shaped oysters, gathered at low tide from Turtle Rock, were planted on the unprepared sticky bottom. The area covered contained 400 square feet, but the bulk of the oysters were placed on the eastern half. A rapid growth took place from the beginning, and, contrary to what was expected, very few of the oysters died. At the end of the third season 71 per cent were living. Very few spat attached to the shells of the oysters. The mud upon which the plant was made contained considerable sand and was quite firm compared with that found on the west side of the bed, so that the oysters did not sink below the surface, although they became covered with a thin coat of sediment.

It will be noted, by reference to the table, that the most favorable results in planting seed oysters, the rate of mortality being considered,

were obtained from this area and area No. 4. The fact that the seed oysters for both of these plantings were brought from localities where the conditions surrounding them were very nearly those on the bed to which they were transplanted should also not escape attention, for to this is probably due a considerable part of the success. The beds in Core Creek, from which the seed for area No. 4 were taken, are surrounded by conditions similar to those on the Newport experimental bed, and Turtle Rock is but a few hundred yards above area No. 22. In no case did the oysters thrive when transplanted from beds located in places where the water differed considerably in its density from that on the experimental beds, and the death rate among the plants increased directly with the increase in this difference. The age of the plants, too, probably has much to do with their ability to adapt themselves to new and different conditions, young seed adjusting itself more readily than old.

Area No. 14.—This area, in Newport River, should receive special attention, since it is one on which no seed oysters were planted, but from which fine marketable oysters were taken during September, 1902. It contains 400 square feet of soft muddy bottom, and was planted with 70 bushels of shells June 30, 1900. If evenly distributed, the layer covering it would be $3\frac{1}{2}$ shells in thickness. At the last examination, made September 12, 1902, there were seventeen oysters more than 3 inches in length to each hundred of the surface shells. If the spat from which these oysters grew became attached on the date when the shells were planted, their age would have been 2 years, 2 months, and 12 days.

Detailed record of planting experiments in Newport and North rivers.

Number of experiment.	Location of planted area.	Size of bed.	Date of planting.	Kind of bottom.	Method of planting.	Date of examination.	Oysters less than ½ inch in length attached to— Concave surface.	Oysters less than ½ inch in length attached to— Convex surface.	Oysters between ½ and 1 inch in length attached to— Concave surface.	Oysters between ½ and 1 inch in length attached to— Convex surface.	Oysters between 1 and 2 inches in length attached to— Concave surface.	Oysters between 1 and 2 inches in length attached to— Convex surface.	Oysters between 2 and 3 inches in length attached to— Concave surface.	Oysters between 2 and 3 inches in length attached to— Convex surface.	Oysters more than 3 inches in length attached to— Concave surface.	Oysters more than 3 inches in length attached to— Convex surface.	Total number of living oysters attached to 100 planted shells.	Total number of dead oysters attached to 100 planted shells.
		Sq. ft.																
1	Newport River	570	Apr. 26, 1900.	Mud	41 bushels shells planted in 5 rows placed obliquely to currents.	Aug. 6, 1900	54	45	93	51	69	40	......	......	......	......	355	233
						June 3, 1901	8	8	41	47	20	24	5	3	......	......	156	108
						Aug. 18, 1901	......	......	......	......	......	......	......	......	......	......	......	640
						Sept. 12, 1902	......	......	......	......	......	......	......	......	......	......	......	20
2	....do	570	....do	Hard sand	40 bushels shells planted in 5 rows placed obliquely to currents.	Aug. 13, 1900	11	5	......	2	......	......	......	......	......	......	18	134
						June 3, 1901	Shells nearly covered with sand.											
						Aug. 18, 1901	Shells covered with sand.											
						Sept. 17, 1902	Do.											
3	North River	750	Apr. 27, 1900.	....do	70 bushels shells planted in 4 rows placed across the currents.	Aug. 13, 1900	35	8	5	6	6	12	......	......	......	......	72	57
						May 30, 1901	Shells nearly covered with sand.											
						Aug. 9, 1901	Shells covered with sand.											
						Sept. 15, 1902	Do.											
4	Newport River	500	May 5, 1900.	Mud	63 bushels shells evenly scattered.	Aug. 16, 1900	8	......	2	......	3	1	......	......	......	......	14	42
						June 3, 1901	3	......	5	2	3	......	......	......	......	......	15	14
						Aug. 6, 1901	16	9	22	4	......	......	......	......	......	......	51	(?)
						Sept. 11, 1902	......	9	......	......	6	11	3	12	1	4	46	33
			May 16, 1900.	Shells	18 bushels oysters from Core Creek reefs evenly scattered.	Aug. 16, 1900	100 per cent of planted oysters living.											
						Aug. 6, 1901	82 per cent of planted oysters living—little or no growth.											
						Sept. 11, 1902	Planted oysters not distinguishable from those grown on bed.											
5	North River	400	May 8, 1900.	Mud	70 bushels shells evenly scattered.	Aug. 13, 1900	15	5	8	3	5	3	......	......	......	......	39	36
						Aug. 9, 1901	95	41	13	22	3	5	8	2	......	......	189	(?)
						Sept. 9, 1902	1	......	1	......	12	3	7	4	1	1	30	18
			May 11, 1900.	Shells	18 bushels oysters from "Howlands" reef evenly scattered.	Aug. 13, 1900	91 per cent of planted oysters living.											
						May 30, 1901	20 per cent of planted oysters living.											
						Aug. 9, 1901	4 per cent of planted oysters living.											
						Sept. 9, 1902	All planted oysters dead.											
6	Newport River	500	May 14, 1900.	Mud	80 bushels shells evenly scattered.	Aug. 16, 1900	35	17	4	1	1	2	......	......	......	......	60	42
						Aug. 17, 1901	88	65	12	4	1	2	......	5	......	......	177	(?)
						Sept. 11, 1902	2	6	9	1	......	1	3	12	1	2	37	62
			May 15, 1900.	Shells	18 bushels oysters from Cross Rock evenly scattered.	Aug. 16, 1900	91 per cent of planted oysters living.											
						Aug. 17, 1901	59 per cent of planted oysters living.											
						Sept. 11, 1902	Planted oysters not distinguishable from those grown on bed.											

7	North River	500	May 20, 1900.	Mud	72 bushels shells evenly scattered.	Aug. 18, 1900	2		9	3							14	7
						June 5, 1901	12	9	5	2							28	4
						Aug. 9, 1901	88	65	12	4	2	1	1				173	(?)
						Sept. 9, 1902	8	8			9	7	5	5			36	27
8	do	400	May 25, 1900.	do	70 bushels shells evenly scattered.	Aug. 18, 1900	3	3	4								10	2
						June 12, 1901	15	14	3	3							35	9
						Aug. 9, 1901	93	48	8	2							151	(?)
						Sept. 9, 1902	3		5	14	22	31	2	4	1		85	41
			May 30, 1900.	Shells	16 bushels oysters from Goose Creek Bay evenly scattered.	Aug. 18, 1900	75 per cent of planted oysters living.											
						Aug. 9, 1901	24 per cent of planted oysters living.											
						Sept. 9, 1902	Practically all of the planted oysters dead.											
9	Newport River	400	May 31, 1900.	Mud	50 bushels shells evenly scattered.	Aug. 22, 1900	6	1	8	2							17	20
						June 3, 1901	2		1	4							7	4
						Aug. 17, 1901	16	8	4	3	3	1					35	(?)
						Sept. 11, 1902	1	2	8	2	3	11	13	18	6	2	66	27
			June 12, 1900.	Shells	15 bushels oysters from Cross Rock evenly scattered.	Aug. 22, 1900	100 per cent of planted oysters living.											
						Aug. 17, 1901	68 per cent of planted oysters living.											
						Sept. 11, 1902	Planted oysters not distinguishable from those grown on bed.											
10	do	200	May 31, 1900.	Mud	30 bushels shells planted in 3 rows parallel to the currents.	Aug. 22, 1900	22	11	30	28	4	7					102	28
						Aug. 17, 1901	20	14	9	17	7	8	5	1			81	(?)
						Sept. 12, 1902	32	15	14	12	1	3	4	5	3	2	91	26
11	North River	240	June 5, 1900.	do	70 bushels shells planted in 3 rows across the currents.	Aug. 18, 1900	87	57	93	48	31	28					344	21
						June 5, 1901	24	22	60	42	8	5					161	26
						Aug. 9, 1901	112	64	14	5	4	4					203	(?)
						Sept. 9, 1902	1		3	2	21	5	6	3			41	39
12	do	200	June 13, 1900.	do	60 bushels shells planted in 2 rows parallel to currents.	Aug. 24, 1900	128	97	156	80	33	15	21	9			539	52
						May 28, 1901	35	24	67	37	5	1					169	40
						Aug. 9, 1901	117	90	16	8	3	1	1	5			241	(?)
						Sept. 11, 1902			2	4	17	5	5	3	1	1	41	28
13	do	400	June 21, 1900.	do	63 bushels shells evenly scattered.	Aug. 24, 1900	61	13	20	7							101	52
						June 5, 1901	18	5	11	5							39	25
						Aug. 18, 1901	55	55	4	1							115	(?)
						Sept. 9, 1902	1	1	3	2	23	19	7	2			58	50
			June 25, 1900.	Shells	15 bushels oysters from Cross Rock evenly scattered.	Aug. 24, 1900	80 per cent of planted oysters living.											
						May 30, 1901	23 per cent of planted oysters living.											
						Aug. 18, 1901	10 per cent of planted oysters living.											
						Sept. 9, 1902	Planted oysters practically all dead.											
14	Newport River	400	June 30, 1900.	Mud	70 bushels shells evenly scattered.	Aug. 22, 1900	59	29	134	63							285	12
						June 4, 1901	8	8	90	76	2	8					192	52
						Aug. 9, 1901	12	14	11	12	52	38					142	(?)
						Sept. 12, 1902	19	14	11	21	9	15	7	17	9	8	130	21
15			July 3, 1900.	do	67 bushels shells planted in 4 rows across the currents.	Aug. 22, 1900	64	41	91	59	23	5					280	42
						June 10, 1901	18	12	41	25	31	3	15	1			147	58
						Aug. 17, 1901	8	6	16	26	88	32					176	(?)
						Sept. 18, 1902	33	46	21	23	2	7	14	29	10	20	215	8
16	North River	500	July 6, 1900.	do	70 bushels shells evenly scattered.	Aug. 24, 1900	6	1	9	6							22	1
						June 12, 1901	27	18	20	7	3						75	
						Aug. 13, 1901	175	148	35	12							370	
						Sept. 18, 1902	2	7	4	2	10	23	8	11	1	1	69	31

Detailed record of planting experiments in Newport and North rivers—Continued.

Number of experiment.	Location of planted area.	Size of bed.	Date of planting.	Kind of bottom.	Method of planting.	Date of examination.	Oysters less than ½ inch in length attached to—		Oysters between ½ and 1 inch in length attached to—		Oysters between 1 and 2 inches in length attached to—		Oysters between 2 and 3 inches in length attached to—		Oysters more than 3 inches in length attached to—		Total number of living oysters attached to 100 planted shells.	Total number of dead oysters attached to 100 planted shells.
							Concave surface.	Convex surface.	Concave surface.	Convex surface.	Concave surface.	Convex surface.	Concave surface.	Convex surface.	Concave surface.	Convex surface.		
		Sq. ft.																
17	Newport River	240	July 10, 1900.	Mud	30 bushels shells planted in 3 rows parallel to currents.	Aug. 28, 1900	81	75	148	103	52	38	......	......	......	......	497	14
						June 4, 1901	4	8	60	67	46	34	8	13	......	......	240	10
						Aug. 9, 1901	12	10	6	10	112	72	7	5	......	......	234	(?)
						Sept. 12, 1902	5	3	5	5	2	4	11	16	7	2	60	10
18	....do	300	....do	....do	33 bushels shells planted in 3 rows across the currents.	Aug. 28, 1900	108	91	297	172	14	5	......	......	......	......	687	40
						June 4, 1901	......	2	90	77	62	44	28	5	......	......	308	30
						Aug. 17, 1901	4	11	30	10	112	94	8	1	......	......	273	(?)
						Sept. 12, 1902	6	6	6	11	3	7	8	14	13	13	87	14
19	North River	400	July 14, 1900.	....do	40 bushels shells planted in 5 rows across the currents.	Aug. 24, 1900	25	6	7	......	......	......	......	......	......	......	38	4
						June 5, 1901	17	17	12	2	6	3	......	......	......	......	57	30
						Sept. 9, 1902	......	......	2	2	31	26	12	18	......	2	93	25
20	....do	120	....do	....do	20 bushels shells planted in 2 rows parallel to currents.	Aug. 24, 1900	26	17	5	1	......	......	......	......	......	......	49	14
						May 30, 1901	54	21	14	9	4	1	......	......	......	......	103	36
						Sept. 9, 1902	......	......	2	2	9	17	5	25	1	5	66	28
21	Newport River	400	July 19, 1900.	....do	60 bushels shells evenly scattered.	Aug. 28, 1900	161	88	186	102	12	3	......	......	......	......	552	29
						Aug. 13, 1901	36	46	45	39	98	72	89	30	......	......	455	(?)
						Sept. 18, 1902	69	4	15	12	8	11	6	7	1	......	133	12
			....do	Shells	10 bushels oysters from Gallants Reef evenly scattered.	Aug. 28, 1900	93 per cent of planted oysters living.											
						Aug. 13, 1901	50 per cent of planted oysters living.											
						Sept. 4, 1902	Planted oysters indistinguishable from those grown on bed.											
22	....do	400	July 20, 1900.	Mud	10 bushels oysters from Turtle Rock evenly scattered.	Aug. 28, 1900	98 per cent of planted oysters living.											
						June 4, 1901	80 per cent of planted oysters living.											
						Aug. 13, 1901	79 per cent of planted oysters living.											
						Sept. 16, 1902	71 per cent of planted oysters living.											
23	....do	400	June 11, 1901.	....do	40 bushels shells planted in 4 rows across the currents.	Aug. 6, 1901	3	2	9	11	5	......	......	......	......	......	30	......
						Sept. 12, 1902	50	10	18	12	11	11	13	22	14	37	198	21
24	....do	200	....do	....do	20 bushels shells planted in 2 rows parallel to currents.	Aug. 6, 1901	2	2	4	4	......	......	......	......	......	......	12	......
						Sept. 13, 1902	18	6	20	9	8	......	6	10	3	5	85	24

25	North River	400	June 12, 1901.	....do	40 bushels shells planted in 4 rows across the currents.	Aug. 18, 1901	194	154	30	11	......	......	......	......	......	......	392	......
						Sept. 16, 1902	3	1	1	2	13	20	36	28	11	13	128	30
26	....do	200	....do	....do	20 bushels shells planted in 2 rows parallel to currents.	Aug. 18, 1901	61	56	7	1	......	......	......	......	......	......	131	......
						Sept. 17, 1902	1	......	3	1	25	26	26	21	2	5	110	29
			Sept. 13, 1901.	....do	16⅔ bushels shells evenly scattered.	Sept. 13, 1902	8	9	14	6	11	6	3	2	......	......	59	21
27	Newport River.	100	Sept. 17, 1901.	Shells	Three bushels oysters from Gallant's Reef evenly scattered.	....do	Planted oysters practically all dead.											
28	....do	400	Sept. 13, 1901.	Mud	16⅔ bushels shells evenly scattered.	....do	6	3	6	8	5	15	2	1	......	......	46	11
29	....do	100	Apr. 30, 1902.	....do	20 bushels shells evenly scattered.	....do	3	8	8	26	8	4	......	......	......	......	57	12
30	....do	200	June 20, 1902.	....do	....do	Sept. 17, 1902	16	43	80	61	56	20	......	......	......	......	276	25
			....do	Shells	Five bushels oysters from Gallants Reef scattered over southern end.	Sept. 4, 1902	95 per cent of planted oysters living.											
31	North River	200	Aug. 13, 1902.	Mud	20 bushels shells evenly scattered.	Sept. 16, 1902	23	36	2	......	......	......	......	......	......	......	61	......

SUMMARY OF WORK AND RESULTS.

In all, 31 beds were made, 18 in Newport River and 13 in North River, representing five methods of planting. On 9 of the beds shells in various quantities were first evenly scattered over the bottom, upon which seed oysters were to be planted. The seed oysters were obtained in different localities and represented various conditions of growth. Some were taken from reefs, and were "coony;" some were tonged from beds known to produce the best marketable oysters of the section; some were obtained from localities where the water usually has a higher specific gravity than that over the experimental beds, and some came from beds over which the water is fresher than on the planted beds. In one instance seed oysters were planted on an unprepared bottom.

The results from planting seed oysters are as follows (an average from the results of all the plants made): At the end of the first season 78 per cent of the oysters were living, but very few were in a growing condition. At the end of the second season 41 per cent only remained alive. Those planted in North River showed no growth and were very poor; those in Newport River, however, had been growing nicely. At the end of the third season no estimate could be made, as it was not possible to distinguish between the oysters which were planted and those which had grown from spat on the beds. The "coon" oysters, planted on 5 of the beds, showed no improvement in shape, and a larger per cent of them died than of the better shaped seed.

Should the same number of new plantings be made, with the methods used in 4, 9, and 22, there is every reason to believe the result would be much more favorable. The per cents given above are cut down very considerably by the results on the beds which were total failures.

Shells were planted in an even layer from 1 to 4 shells in thickness on 6 beds for the purpose of catching spat. To this number may be added the 9 beds which were hardened with shells as a foundation before planting seed oysters, for spat attached to the shells of these beds, and they were regularly examined. The average number of spat counted on a hundred shells tonged from each of these 15 beds at the end of the first season was 97. The number of spat and oysters on the same number of shells taken in the same manner from the same beds at the end of the second season was 157. At the end of the season of 1902, a majority of the oysters were 2 or more inches in length, the total number per hundred shells being 58.

On 9 beds shells were planted in ridges parallel to the currents flowing over them, and on 6, ridges of shells were made across the currents. Examination of the shells from the beds on which the ridges were placed across the currents showed that each hundred shells had caught 303 spat at the end of the first season. (In all the figures none but

living oysters are included.) At the end of the second and third seasons the number of spat and oysters on each hundred shells was 163 and 87, respectively. The shells planted in ridges parallel to the currents caught fewer spat than those planted in ridges making a right angle with the direction of flow, but under both conditions too much spat was caught and coony oysters were in many cases the result. The average catch of spat on each hundred shells on the parallel ridges for the first, second, and third seasons was 221, 150, and 64, respectively. The growth of the oysters which caught to the shells was remarkably rapid, as is shown by the fact that from one of the beds on which no seed were planted, oysters were available for use toward the close of the season of 1902.

From April to September in 1900 large numbers of spat became attached to shells whenever and wherever planted, but the tabulated results of the examinations show that the conditions for their attachment and growth were more favorable in Newport than in North River. The shells on both experimental beds became the home also of innumerable barnacles, crabs, worms, polyzoa, ascidians, sponges, anemones, leptogordias, mussels, and various algæ. During the second year, however, the water became brackish, and all of these animals were killed except the barnacles, crabs, and mussels, which, like the oyster, are adapted to such conditions. The freshness of the water had a decided effect upon the catch of spat also, the number that became attached in Newport River being much smaller than during the previous year, while in North River exactly the opposite occurred. From this it appears that the most favorable conditions for the life of oyster larvæ and their attachment are brought about in North River during a wet season and in Newport River during a drought. This conclusion is borne out by the results during the following dry season of 1902, when the number of oysters that attached to shells on the Newport River bed was much greater than in 1901, while in North River it fell far short.

CONCLUSIONS.

The results of the experiments are, on the whole, satisfactory. Several important facts have been demonstrated which can not fail to have a bearing upon any future operations in oyster culture in North Carolina. The lower parts of Newport and North rivers are not adapted to oyster culture. Oysters grow there in abundance when supported above the mud, but there is too much uncertainty connected with the crop to justify practical planting operations. When the time comes to place the oysters on the market they are too often not in salable condition. This is traceable to the high density of the water of these portions of the rivers. Should the industry in Pamlico Sound ever be developed to such an extent as to create a demand for seed oysters, however, the ground in the lower parts of these rivers

will become valuable, for when cultch is exposed a good catch of spat is almost a certainty.

The upper parts of the rivers, on the other hand, are well adapted to oyster planting and, during all but the very dry seasons, there is every reason to believe that planters would be able to market their crop. The industry could never be extensive on account of the small amount of available ground, but between the natural beds there are many acres that might be utilized for purposes of planting. The natural beds themselves, if strewn with shells at some time during the summer months, could easily be made to yield many times the amount of oysters that is annually taken from them. They are public property, and no individual can be expected to be so public spirited as to as to plant the shells, but it might be done by the State, in one instance at least, as an experiment.

It is better to strew shells and stock beds from spat than to plant large seed oysters. The latter do not recover from the shock they have undergone in the rough handling and in the sudden change in their habitat until spat caught at the time of planting the seed oysters have attained an equal size.

Under favorable conditions some oysters may be marketed the third season after the shells are put down. Oysters of excellent shape, 2½ inches in length, can be raised in abundance in one year from the date of planting shells. Such oysters are well suited to the half-shell trade, and a profitable industry for a limited number of planters might be developed along this line.

When oysters are planted, the stock should be young, as it then more readily adapts itself to new conditions than does old seed. Large "coony" oysters are worthless as seed, since they are incapable of improvement, even when planted in the most favorable environment. Very badly shaped young oysters, however, soon regain their normal shape when placed under favorable conditions, as has been shown by Mr. Glaser in some experiments carried on in 1902, and which are described by him on page 329 of this report.

Shells intended as spat collectors (in Newport and North rivers) should be strewn over the bottom rather than planted in rows. In the latter case too much spat usually becomes attached, and "coony" oysters are the result. The proper amount of shells to be planted should be determined by the character of the bottom. The softer and deeper the mud the more shells should be used. In no case should less than 2,000 bushels per acre be planted, but the cases are few where more than 5,000 bushels would be needed. Using the first amount, the bottom would be covered with a layer one shell in thickness. The aim should be to plant enough shells to prevent those on top from settling below the surface. In the greater number of the experiments the results show that too many shells have been used.

June and July are the best months in which to plant shells intended as spat collectors, although a set was secured upon shells planted from April to September. Spat also attached during the summers of 1901 and 1902 to shells planted in 1900.

Shells or oysters should never be planted on a sandy bottom in Newport or North rivers. This conclusion will probably not apply to sandy bottoms in Pamlico Sound, where the sand is often held together by grass roots and thus prevented from shifting.

Steamed oyster shells make excellent spat collectors. They are cheap and are available in immense quantities at various accessible points on the North Carolina coast.

Oyster planting should not be undertaken by any but experienced oystermen. So much depends upon the selection of the site and upon the methods of planting and caring for the beds that failure must be regarded as the probable result of careless work.

OYSTER PLANTING IN PAMLICO SOUND.

Numerous attempts have been made from time to time at many places in Pamlico Sound to establish private oyster grounds, but as yet they have not proved successful.

The following table, compiled by Mr. C. H. Stevenson, shows the approximate number and the extent of the grants in Pamlico Sound for the purpose of oyster culture since 1872. It must be remembered that this enumeration does not include the enormous number of entries made, but for which grants have never been asked. Under the enactment of 1887 as many as 1,067 entries were made in Hyde County alone:

Grants for oyster culture in Pamlico Sound.

Year.	Dare County.		Hyde County.		Pamlico County.	
	Grants.	Acres.	Grants.	Acres.	Grants.	Acres.
1873			1	8		
1875			2	17		
1876			8	82		
1877			3	27		
1878					1	9
1879					2	17
1880			1	10		
1881					2	19
1882	2	18	1	9	1	8
1884	18	171			3	27
1885	4	37	6	55	12	101
1886	3	16			8	76
1887			2	12		
1888			10	69		
1889	6	56	153	1,888		
1890	21	201	28	250		
1891	3	28	23	216	8	80
1892			22	230		
1893			10	100		
1894	1	10	35	330		
1895	2	16				
Total	30	553	305	2,603	37	337

In 1900 practically all of these grounds had been abandoned by the owners. Those which are held and on which the taxes had been paid were as follows:

Oyster grants on which taxes were paid.

	Number.	Acres.
Hyde County:		
Lake Landing	56	477
Ocracoke	7	41
Swan Quarter	3	162
Pamlico County:		
Township No. 2	6	74
Township No. 4	1	80
Total	73	834

The causes of this condition of the industry in Pamlico Sound, judging from its history here and in other oyster-producing sections, are:

(1) Those who have engaged in it have, as a rule, had erroneous ideas as to the requirements for successful oyster culture. They were not aware how very much depends upon the selection of ground, the accessibility of an abundant food supply, the specific gravity of the water and its freedom from extreme fluctuations, the time and methods of planting cultch and oysters, etc.

(2) Many of those who entered ground for oyster planting did so with the expectation that large profits would be immediately forthcoming, and were not sufficiently interested to continue in the work when they had ascertained by experience that this is no more profitable than other industries and requires a corresponding amount of time and labor.

(3) The laws framed for the encouragement and protection of oyster culture were defective or have not been observed.

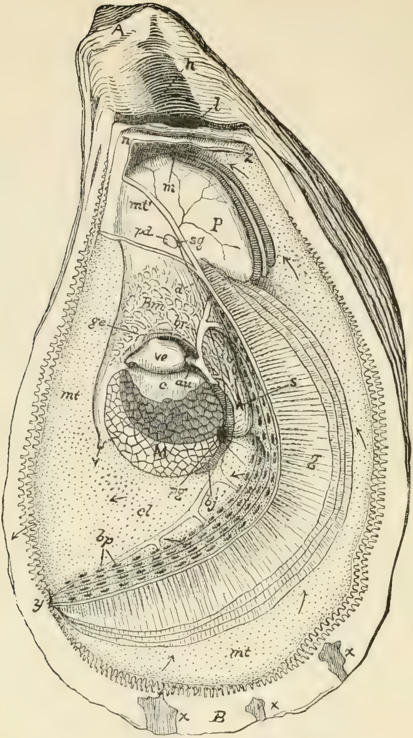
Private grounds in Pamlico Sound have in many cases proved to have been well selected and have produced oysters of a good quality, but the owners of such grounds have, in some notable instances, not been allowed to market the crop; they have been powerless to prevent their grounds from being treated as public property. Oystermen when arrested for trespassing in such cases have been able, invariably, to obtain their release without fine or imprisonment by asserting that the planted grounds when laid off contained natural oyster beds, and no difficulty has been experienced by them in finding a multitude of witnesses to substantiate their statements; this in spite of the fact that careful surveys of the grounds previous to obtaining grants or planting the oysters failed to discover any natural oyster beds.

From a biological standpoint Pamlico Sound offers a wide and promising field for oyster culture. The results of the survey of sections 10 and 16 demonstrate beyond doubt that (*a*) oyster food is abundant in these sections; (*b*) many localities exist not now occupied by oysters

in which the water has the necessary specific gravity and is not readily disturbed by freshets; (*c*) oysters have grown as well when transplanted to ground adjoining natural beds as on the natural beds themselves; and (*d*) in the regions where natural beds exist spat can be secured if cultch be supplied.

If it is the wish of the people of North Carolina to encourage the development of an industry in oyster culture it can be accomplished (1) by amending the laws relating to the entry of grounds for this purpose; (2) by creating a proper sentiment in this direction, and (3) by supplying to the people of eastern North Carolina accurate information relative to all phases of the subject.

To aid in the accomplishment of this result has been the object and purpose of the North Carolina Geological Survey and the United States Fish Commission in conducting the survey and experiments of which this is the final report, and in conducting the further investigations now under way in Pamlico Sound, the results of which will soon be ready for publication.



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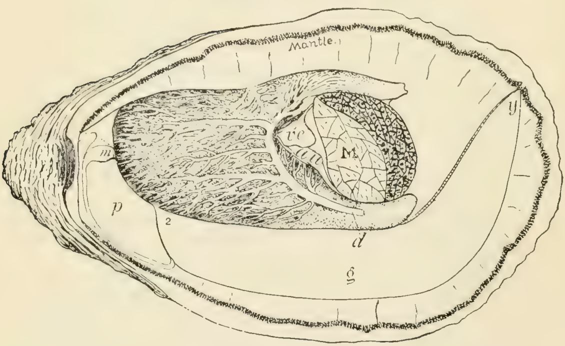

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FIG. 1. Oyster with right shell and mantle removed. *a* and *a*, origin of arteries from the ventricle; *au*, auricle of heart; *br*, vessel carrying blood from the gills to the auricle of the heart; *bj*, outline of organ of Bojanus, the so-called kidney; *bp*, pores from which the water issues into the branchial canals after passing through the gills; *cl*, cloaca; *d*, *pg*, and *sg*, connective and two ganglia of the nervous system; *g*, gills; *gc*, cavity between the two mantle folds; *h*, hinge; *l*, ligament; *M*, adductor muscle; *m*, mouth; *mt*, mantle, the arrows show the direction of currents produced by the cilia; *p*, palps; *p'*, outer end of right pedal muscle; *s*, external opening of sexual and renal organs of right side; *v*, anus; *ve*, ventricle of heart.

FIG. 2. Diagram to show sexual organs of the oyster. *d*, duct of sexual gland. Other letters as above.

ANATOMY, EMBRYOLOGY, AND GROWTH OF THE OYSTER.

By H. F. Moore.[a]

ANATOMY.

The following popular description of the anatomy of the oyster is extracted from the writings of Professors Brooks and Ryder:

The general structure of an oyster may be roughly represented by a long, narrow memorandum book, with the back at one of the narrow ends instead of one of the long ones. The covers of such a book represent the two shells of the oyster, and the back represents the hinge, or the area where the two valves of the shell are fastened together by the hinge ligament. (Plate VII, fig. 1 *l*.) This ligament is an elastic, dark-brown structure, which is placed in such a relation to the valves of the shell that it tends to throw their free ends a little apart. In order to understand its manner of working, open the memorandum book and place between its leaves, close to the back, a small piece of rubber to represent the ligament. If the free ends of the cover are pulled together the rubber will be compressed and will throw the covers apart as soon as they are loosened. The ligament of the oyster shell tends, by its elasticity, to keep the shell open at all times, and while the oyster is lying undisturbed upon the bottom, or when its muscle is cut, or when the animal is dying or dead, the edges of the shell are separated a little.

The shell is lined by a thin membrane, the mantle (plate VII, fig. 1 *mt*), which folds down on each side, and may be compared to the leaf next the cover on each side of the book. The next two leaves of each side roughly represent the four gills, *g*, the so-called "beard" of the oyster, which hang down like leaves into the space inside the two lobes of the mantle. The remaining leaves may be compared to the body or visceral mass of the oyster.

Although the oyster lies upon the bottom, with one shell above and one below, the shells are not upon the top and bottom of the body, but upon the right and left sides. The two shells are symmetrical in the young oyster (plate VIII, fig. 2), but after it becomes attached the lower or attached side grows faster than the other, and becomes deep and spoon-shaped, while the free valve remains nearly flat. In nearly every case the lower or deep valve is the left. As the hinge marks the anterior end of the body, an oyster which is held on edge, with the hinge away from the observer, and the flat valve on the right side, will be placed with its dorsal surface uppermost, its ventral surface below, its anterior end away from the observer, and its posterior end toward him, and its right and left sides on his right and left hands, respectively.

In order to examine the soft parts, the oyster should be opened by gently working a thin, flat knife-blade under the posterior end of the right valve of the shell, and pushing the blade forward until it strikes and cuts the strong adductor muscle, *M*, which passes from one shell to another and pulls them together. As soon as this

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[a] Reprinted from "Oysters and Methods of Oyster Culture," Report U. S. Fish Commission, 1897, pp. 270–279.

muscle is cut the valves separate a little, and the right valve may be raised up and broken off from the left, thus exposing the right side of the body. The surface of the body is covered by the mantle, a thin membrane which is attached to the body over a great part of its surface, but hangs free like a curtain around nearly the whole circumference. By raising its edge, or gently tearing the whole right half away from the body, the gills, *g*, will be exposed. These are four parallel plates which occupy the ventral half of the mantle cavity and extend from the posterior nearly to the anterior end of the body. Their ventral edges are free, but their dorsal edges are united to each other, to the mantle, and to the body. The space above, or dorsal to the posterior ends of the gills, is occupied by the oval, firm adductor muscle, *M*, the so-called "heart." For some time I was at a loss to know how the muscle came to be called the "heart," but a friend told me that he had always supposed that this was the heart, since the oyster dies when it is injured. The supposed "death" is simply the opening of the shell, when the animal loses the power to keep it shut. Between this muscle and the hinge the space above the gills is occupied by the body, or visceral mass, which is made up mainly of the light-colored reproductive organs and the dark-colored digestive organs, packed together in one continuous mass.

If the oyster has been opened very carefully, a transparent, crescent-shaped space will be seen between the muscle and the visceral mass. This space is the pericardium, and if the delicate membrane which forms its sides be carefully cut away, the heart, *ve* and *au*, may be found without any difficulty lying in this cavity and pulsating slowly. If the oyster has been opened roughly, or if it has been out of water for some time, the rate of beating may be as low as one a minute, or even less, so the heart must be watched attentively for some time in order to see one of the contractions.

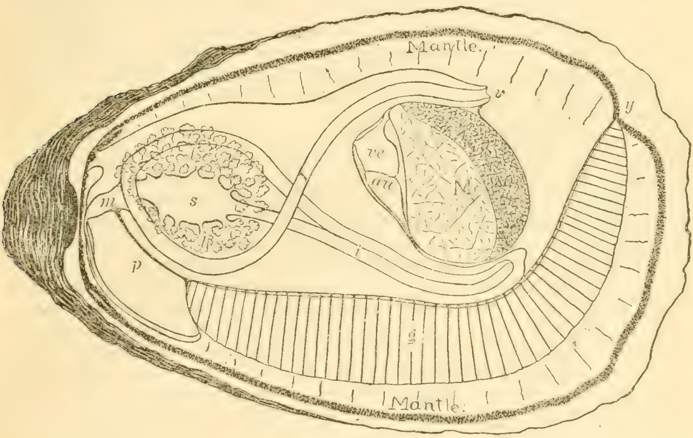
* * * * * * *

In front of the gills, that is between them and the hinge, there are four fleshy flaps—the lips, *p*, two on each side of the body. They are much like the gills in appearance, and they are connected with each other by two ridges, which run across the middle of the body close to the anterior end, and between these folds is the large oval mouth, *m*, which is thus seen to be situated, not at the open end of the shell, but as far away from it as possible. As the oyster is immovably fixed upon the bottom, and has no arms or other structures for seizing food and carrying it to the mouth, the question how it obtains its food at once suggests itself. If a fragment of one of the gills is examined with a microscope it will be found to be covered with very small hairs, or cilia, arranged in rows, plate IX, fig. 3, *c*. Each of these cilia is constantly swinging back and forth with a motion something like that of an oar in rowing. The motion is quick and strong in one direction and slower in the other. As all the cilia of a row swing together they act like a line of oars, only they are fastened to the gill, and as this is immovable they do not move forward through the water, but produce a current of water in the opposite direction. This action is not directed by the animal, for it can be observed for hours in a fragment cut out of the gill, and if such a fragment be supplied with fresh sea water the motion will continue until it begins to decay. While the oyster lies undisturbed on the bottom, with its muscle relaxed and its shell open, the sea water is drawn on to the gills by the action of the cilia, for although each cilium is too small to be seen without a microscope, they cover the gills in such great numbers that their united action produces quite a vigorous stream of water, which is drawn through the shell and is then forced through very small openings on the surfaces of the gills into the water tubes inside the gills, and through these tubes into the cavity above them, and so out of the shell again. As the stream of water passes through the gills the blood is aerated by contact with it.

The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water

strains through the pores into the water tubes the food particles are caught on the surface of the gills by a layer of adhesive slime, which covers all the soft parts of the body. As soon as they are entangled the cilia strike against them in such a way as to roll or slide them along the gills toward the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forward until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the œsophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.

The cilia and particles of food are too small to be seen without a microscope, but if finely powdered carmine be sprinkled over the gills of a fresh oyster, which has been carefully opened and placed in a shallow dish of sea water, careful observation will show that as soon as the colored particles touch the gills they begin to slide along with a motion which is quite uniform, but not much faster than that of the



minute-hand of a watch. This slow, steady, gliding motion, without any visible cause, is a very striking sight, and with a little care the particles may be followed up to and into the mouth.

In order to trace the course of the digestive organs the visceral mass may be split with a sharp knife or razor. If the split is pretty near the middle of the body, each half will show sections of the short, folded œsophagus, running upward from the mouth and the irregular stomach, *s* (see cut) with thick, semitransparent walls, surrounded by the compact, dark-greenish liver, *l l*. Back of the liver and stomach the convoluted intestine, *i*, will be seen, cut irregularly at several points by the section.

There are no accessory organs of reproduction, and the position, form, and general appearance of the reproductive organ, plate VII, fig. 2, is the same in both sexes. As the reproductive organ has an opening on each side of the body, it is usually spoken of as double, but in the adult oyster it forms one continuous mass, with no trace of a

division into halves, and extends entirely across the body and (against) the bends and folds of the digestive tract.[a]

* * * * * * *

The stomach is pretty definitely marked off from the other portions of the digestive tract. It may be said to be that portion of the latter which is surrounded by the liver. The portion of the intestine immediately following the short, widened region which we regarded as the stomach is the most spacious portion of the gut, and in it is lodged a very singular organ, which has been called the "crystalline style." This is an opalescent rod of a glass-like transparency and gelatinous consistence, which measures, according to the size of the oyster, from half an inch up to one and a half inches in length. Its anterior end is the largest, and in a large specimen measures nearly an eighth of an inch in diameter, but at its posterior end is scarcely half as thick; both ends are bluntly rounded. I fell into an error in supposing that this style was lodged in a special pouch or sac, as described in my report to the Maryland commissioner in 1880. The "crystalline style" really lies in the first portion of the intestine and extends from the pyloric end of the stomach to the first bend of the intestine, where there is a marked constriction of the alimentary canal. It appears, therefore, to be a sort of loose valve in the cavity of the gut; its function may be to prevent coarse particles of food from passing, or it may in some way assist digestion. In specimens hardened in acid or alcohol this rod is destroyed, or at least disappears, so that I have been unable to find it. The greater portion of its substance is apparently made up of water.

The peculiar double induplication of the wall of the intestine is described in another place. The fecal matters are extruded in the form of a demicylinder, with one side excavated in a groove-like manner. This shape of the fecal matters is due to the presence of the double fold. The feces themselves are composed of extremely fine particles of quartz or sand grains, the tests of diatoms, organic matter, humus, cellulose, fragments of the chitinous coverings of some of the minute worms and articulates, etc., which have been swallowed and digested by the animal. The anus, *r*, is situated on the dorsal side of the great adductor muscle where the intestine ends.

The organs of sensation of the oyster, though not very highly developed, are of sufficient importance to merit attention. The auditory sense, although I have never been able to dissect out the auditory vesicles, I am satisfied exists, because one can not noisily approach an oyster bank where the oysters are feeding without their hearing so that instantly every shell is closed. The tentacles of the mantle are often extended until their tips reach beyond the edges of the valves. If the animal in this condition is exposed to a strong light, the shadow of the hand passing over it is a sufficient stimulus to cause it to retract the mantle and tentacles and to close its parted valves. The mantle incloses, like a curtain, the internal organs of the creature on either side, and lies next the shell, and, as already stated, secretes and deposits the layers of calcic carbonate composing the latter. The free edges of the mantle, which are purplish, are garnished with small, highly sensitive tentacles of the same color. These tentacles are ciliated and serve as organs of touch, and also appear to be to some extent sensitive to light.

The nervous system of the oyster is very simple, and, as elsewhere stated, is to some extent degenerate in character. It is composed of a pair of ganglia or knots of nervous matter, plate VII, fig. 1, *sg*, which lie just over the gullet, and from these a pair of nervous cords, *d*, pass backward, one on each side, to join the hinder pair which lie just beneath the adductor muscle, *pg*. The mantle receives nerve branches from the hindmost ganglia or knots of nervous matter; these, as their centers, control the contraction and elongation of the radiating bundle of muscular fibers, as well as those which lie lengthwise along the margin; the former contract and withdraw the

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[a] Brooks, W. K.: Studies from the Biological Laboratory of Johns Hopkins University, No. IV, 1888, pp. 5-10 in part.

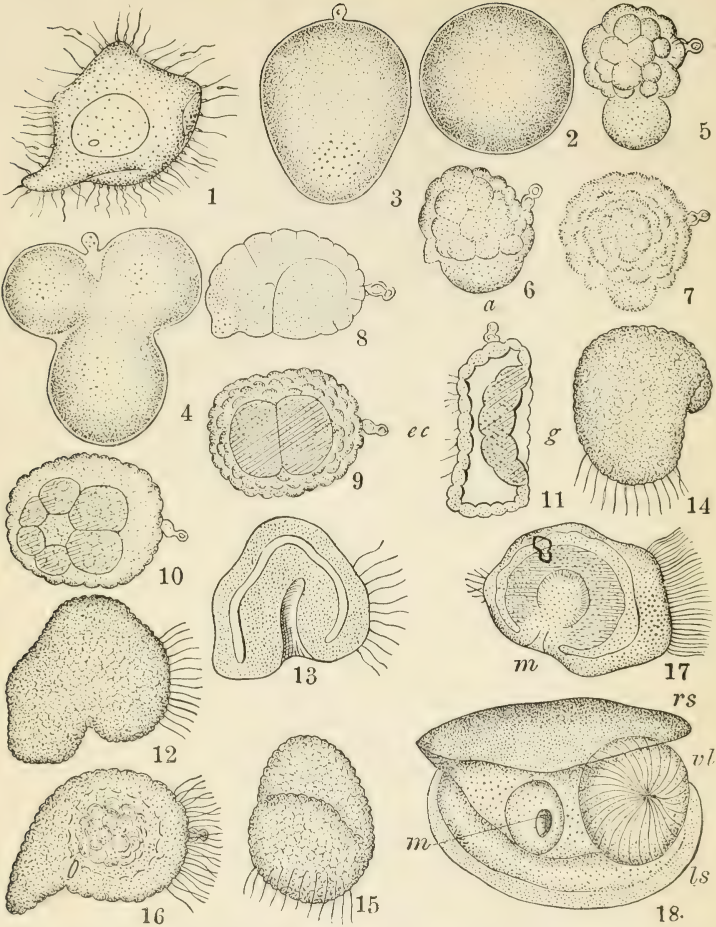


FIG. 1. Unfertilized egg shortly after mixture of spawn and milt; spermatozoa are adhering to the surface.
FIG. 2. Egg after fertilization.
FIG. 3. Same egg 2 minutes later. Polar body at broad end.
FIG. 4. Same egg 6 minutes later.
FIG. 5. About 6½ hours later.
FIG. 6. Another egg at about the same stage. Mass of small cells growing over large cell or macromere *a*.
FIG. 7. Egg 55 minutes later. Macromere almost covered by small cells of ectoderm.
FIG. 8. Optical section of egg 27 hours after impregnation, showing two large cells, derived from *a* in fig 6, covered by a layer of small ectodermal cells.
FIG. 9. Egg a few hours older, showing large cells viewed from below.
FIG. 10. An egg somewhat older viewed from above, showing further subdivision of large cells as seen through cells of upper layer.
FIG. 11. An older egg, now become flattened from above downward. Viewed in optical section.
FIG. 12. Surface view of an embryo just beginning to swim.
FIG. 13. Optical section of same.
FIG. 14. Surface view of same from another position.
FIG. 15. Surface view of same from another position.
FIG. 16. An older embryo in same position as in fig 12
FIG. 17. A still older embryo showing spherical ciliated digestive cavity opening by mouth, *m*.
FIG. 18. An embryo with well-developed larval shells, older than fig. 1, Plate VIII. *rs*, right shell; *ls*, left shell; *vl*, velum; *m*, mouth.

After W. K. Brooks.

edges of the mantle from the margin of the shell, while the latter in contracting tend to crimp or fold its edges. The tentacles are mainly innervated by fibers emanating from the hindmost ganglia, while the internal organs are innervated from the head or cephalic ganglia. The hind ganglia also preside over the contraction of the great adductor muscle. The nerve threads which radiate outward from it to the tentacles dispatch the warnings when intruders are at hand that it must contract and close the shells.[a]

EMBRYONIC DEVELOPMENT.

The following popular account of the early stages in the development of the oyster is slightly modified from the description by Dr. W. K. Brooks:

The ovarian eggs are simply the cells of an organ of the body, the ovary, and they differ from the ordinary cells only in being much larger and more distinct from each other, and they have the power, when detached from the body, of growing and dividing up into cells, which shall shape themselves into a new organism like that from whose body the egg came. Most of the steps in this wonderful process may be watched under the microscope, and, owing to the ease with which the eggs of the oyster may be obtained, this is a very good egg to study.

About 15 minutes after the eggs are fertilized they will be found to be covered with male cells, as shown in plate VIII, fig. 1.[b] In about an hour the egg will be found to have changed its shape and appearance. It is now nearly spherical, as shown in plate VIII, fig. 2, and the germinative vesicle is no longer visible. The male cells may or may not still be visible upon the outer surface. In a short time a little transparent point makes its appearance on the surface of the egg and increases in size and soon forms a little projecting transparent knob—the *polar globule*—which is shown in fig. 3, plate VIII, and in succeeding figures.

Recent investigations tend to show that while these changes are taking place one of the male cells penetrates the protoplasm of the egg and unites with the germinative vesicle, which does not disappear but divides into two parts, one of which is pushed out of the egg and becomes the polar globule, while the other remains behind and becomes the nucleus of the developing egg, but changes its appearance so that it is no longer conspicuous. The egg now becomes pear-shaped, with the polar globule at the broad end of the pear, and this end soon divides into two parts, so that the egg (fig. 4, plate VIII) is now made of one large mass and two slightly smaller ones, with the polar globule between them.

The later history of the egg shows that at this early stage the egg is not perfectly homogeneous, but that the protoplasm which is to give rise to certain organs of the body has separated from that which is to give rise to others.

The upper portion of the egg soon divides up into smaller and smaller spherules, until at the stage shown in figs. 5, 6, and 7, plate VIII, we have a layer of small cells wrapped around the greater part of the surface of a single large spherule, and the series of figures shows that the latter is the spherule which is below in fig. 4, plate VIII. This spherule now divides up into a layer of cells, and at the same time the egg, or rather the embryo, becomes flattened from above downward and assumes the shape of a flat oval disk. Figs. 10 and 9, plate VIII, are views of the upper and lower surface of the embryo at about this time. In a sectional view, fig. 11, plate VIII, it is seen to be made of two layers of cells, an upper layer of small transparent cells, *e c*, which are

[a] Ryder, John A.: Fishery Industries of the United States, pp. 714-715.
[b] References to figures in quoted portions of this paper do not correspond with the originals, being altered to accord with their sequence in the present article.

to form the outer wall of the body and which have been formed by the division of the spherules which occupy the upper end of the egg in fig. 6, plate VIII, and a lower layer of much larger, more opaque cells, *g*, which are to become the walls of the stomach, and which have been formed by the division of the large spherule, *a*, of fig. 6, plate VIII.

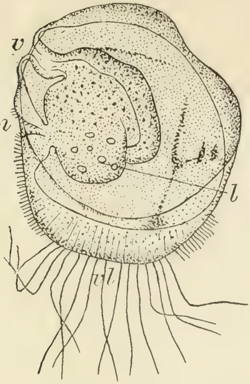
This layer is seen in the section to be pushed in a little toward the upper layer, so that the lower surface of the disk-shaped embryo is not flat, but very slightly concave. This concavity is destined to grow deeper until its edges almost meet, and it is the rudimentary digestive cavity. A very short time after this stage has been reached, and usually within from two to four hours after the eggs were fertilized, the embryo undergoes a great change of shape and assumes the form which is shown in three different views in figs. 12, 13, 14, and 15, plate VIII.

A circular tuft of long hairs or cilia has now made at its appearance at what is thus marked as the anterior end of the body, and as soon as these hairs are formed they begin to swing backward and forward in such a way as to constitute a swimming organ, which rows the little animal up from the bottom to the surface of the water, where it swims around very actively by the aid of its cilia. This stage of development, fig. 12, plate VIII, which is of short duration, is of great importance in raising the young oysters, for it is the time when they can best be siphoned off into a separate vessel and freed from the danger of being killed by the decay of any eggs which may fail to develop. On one surface of the body at this stage, the dorsal surface, there is a well-marked groove, and when a specimen is found in a proper position for examination the opening into the digestive tract is found at the bottom of this groove. Fig. 13, plate VIII, is a sectional view of such an embryo. It is seen to consist of a central cavity, the digestive cavity, which opens externally on the dorsal surface of the body by a small orifice, the primitive mouth, and which is surrounded at all points, except at the mouth, by a wall which is distinct from the outer wall of the body. Around the primitive mouth these two layers are continuous with each other.

The way in which this cavity, with its wall and external opening, has been formed will be understood by a comparison of fig. 13, plate VIII, with fig. 8, plate VIII. The layer which is below in fig. 8, plate VIII, has been pushed upward in such a way as to convert it into a long tube, and at the same time the outer layer has grown downward and inward around it, and has thus constricted the opening. The layer of cells which is below in fig. 8, plate VIII, thus becomes converted into the walls of the digestive tract, and the space which is outside and below the embryo, in fig. 8, plate VIII, becomes converted into an inclosed digestive cavity, which opens externally by the primitive mouth.

This stage of development, in which the embryo consists of two layers, an inner layer surrounding a cavity which opens externally by a mouth-like opening, and an outer layer which is continuous with the inner around the margins of the opening, is of very frequent occurrence, and it has been found, with modifications, in the most widely separated groups of animals, such as the starfish, the oyster, and the frog; and some representatives of all the larger groups of animals, except the protozoa, appear to pass during their development through a form which may be regarded as a more or less considerable modification of that presented by our embryo oyster. This stage of development is known as the *gastrula* stage.

The edges of the primitive mouth of the oyster continue to approach each other and finally meet and unite, thus closing up the opening, as shown in fig. 16, plate VIII, and leaving the digestive tract without any communication with the outside of the body, and entirely surrounded by the outer layer. The embryo shown in figs. 12 and 16, plate VIII, are represented with the dorsal surface below, in order to facilitate comparison with the adult, but in fig. 17, plate VIII, and most of the following figures, the dorsal surface is uppermost, for more ready comparison with the adult.



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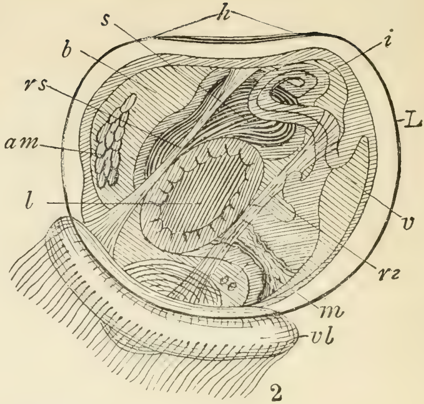

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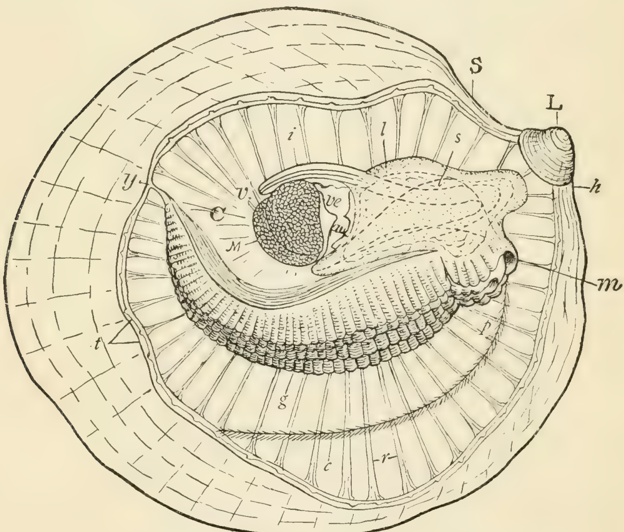

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FIG. 1. View of right side of embryo about 6 days old. *m*, mouth; *v*, vent; *l*, right lobe of liver; *vl*, velum.

FIG. 2. Older larva of European oyster, *Ostrea lurida*. *L*, shell; *h*, hinge; *rs* and *ri*, retractor muscles of the velum, *vl*; *s*, stomach; *i*, intestine; *am*, larval adductor muscle; *b*, body cavity. Other letters as in the preceding.

FIG. 3. Attached spat of *Ostrea virginica*. *S*, shell of spat with larval shell, *L*, at the beak or umbo; *p*, palps; *g*, gills; *c*, diagrammatic representation of a single row of cillia extending from the mantle border to the mouth *m*; *r*, radiating muscle fibres of mantle; *t*, rudimentary tentacles of mantle border; *M*, permanent adductor muscle; *C*, cloaca; *ve* and *au*, ventricle and auricle of the heart; *y*, posterior extremity of the gills and junction of the mantle folds. Other figures as above. Compare this figure with Pl. I, fig. 1.

Fig. 1 after W. K. Brooks. Fig. 2 after Thomas H. Huxley. Fig. 3 after John A. Ryder.

In other lamellibranchs, and doubtless also in the oyster, the shell begins as a deposit in an invagination or pocket on the dorsal side of the body. In its manner of formation this shell gland resembles the primitive mouth for which it has been more than once mistaken by investigators. In some forms the shell is at first single, but in the oyster the two are said to be separated from each other from the beginning, and appear independently. Doctor Brooks says further:

Soon after they make their appearance, the embryos cease to crowd to the surface of the water and sink to various depths, although they continue to swim actively in all directions, and may still be found occasionally close to the surface. The region of the body which carries the cilia now becomes sharply defined, as a circular projecting pad, the *velum*, and this is present and is the organ of locomotion at a much later stage of development. It is shown at the right side of the figure in plate VIII, fig. 17, and in fig. 18, plate VIII, it is seen in surface view, drawn in between the shells, and with its cilia folded down and at rest, as they are seen when the little oyster lies upon the bottom.

The two shells grow rapidly, and soon become quite regular in outline, as shown in plate VIII, fig. 17, and plate IX, fig. 1, but for some time they are much smaller than the body, which projects from between their edges around their whole circumference, except that along a short area, the area of the hinge upon the dorsal surface, where the two valves are in contact. .

The two shells continue to grow at their edges, and soon become large enough to cover up and project a little beyond the surface of the body, as shown in plate IX, fig. 1, and at the same time muscular fibers make their appearance and are so arranged that they can draw the edge of the body and the velum in between the edges of the shells in the manner shown in plate VIII, fig. 18. In this way that surface of the body which lines the shell becomes converted into the two lobes of the mantle, and between them a mantle cavity is formed, into which the velum can be drawn when the animal is at rest. While these changes have been going on over the outer surface of the body other important internal modifications have taken place. We left the digestive tract at the stage shown in plate VIII, fig. 16, without any communication with the exterior.

Soon the outer wall of the body becomes pushed inward to form the true mouth, at a point (plate VIII, fig. 17) which is upon the ventral surface and almost directly opposite the point where the primitive mouth was situated at an earlier stage. The digestive cavity now becomes greatly enlarged and cilia make their appearance upon its walls, the mouth becomes connected with the chamber which is thus formed and which becomes the stomach, and minute particles of food are drawn in by the cilia and can now be seen inside the stomach, where the vibration of the cilia keep them in constant motion. Up to this time the animal has developed without growing, and at the stage shown in plate VIII, fig. 16, it is scarcely larger than the unfertilized egg, but it now begins to increase in size. The stages shown in plate IX, fig. 1, and plate VIII, fig. 18, agree pretty closely with the figures which the European embryologists give of the oyster embryo at the time when it escapes from the mantle chamber of its parent. The American oyster reaches this stage in from twenty-four hours to six days after the egg is fertilized, the rate of development being determined mainly by the temperature of the water.

Soon after the mantle has become connected with the stomach this becomes united to the body wall at another point a little behind the mantle, and a second opening, the anus, is formed. The tract, which connects the anus with the stomach, lengthens and forms the intestine, and soon after the sides of the stomach become folded off to form the two halves of the liver, as shown in plate IX, fig. 1. Various muscular

fibers now make their appearance within the body, and the animal assumes the form shown in plate IX, fig. 1, and plate VIII, fig. 18.[a]

What follows this stage may be best told in the words of Professor Huxley, who speaks of the European oyster, in which the metamorphosis from the free-swimming fry to the fixed spat and finally the adult oyster is essentially the same as in our species:

The young animal which is hatched out of the egg of the oyster is extremely unlike the adult, and it will be worth while to consider its character more closely than we have hitherto done.

Under a tolerably high magnifying power the body is observed to be inclosed in a transparent but rather thick shell (plate IX, fig. 2, *L*), composed, as in the parent, of two valves united by a straight hinge, *h*. But these valves are symmetrical and similar in size and shape, so that the shell resembles that of a cockle more than it does that of an adult oyster. In the adult the shell is composed of two substances of different character, the outer brownish, with a friable prismatic structure, the inner dense and nacreous. In the larva there is no such distinction, and the whole shell consists of a glassy substance devoid of any definite structure.

The hinge line answers, as in the adult, to the dorsal side of the body. On the opposite or ventral side the wide mouth *m* and the minute vent *v* are seen at no great distance from one another. Projecting from the front part of the aperture of the shell there is a sort of outgrowth of the integument of what we may call the back of the neck into a large oval thick-rimmed disk termed the *velum*, *vl*, the middle of which presents a more or less marked prominence. The rim of the disk is lined with long vibratile cilia, and it is the lashing of these cilia which propels the animal, and, in the absence of gills, probably subserves respiration. The funnel-shaped mouth has no palps; it leads into a wide gullet, and this into a capacious stomach. A sac-like process of the stomach on either side (the left one, *l*, only is shown in fig. 2) represents the "liver." The narrow intestine is already partially coiled on itself, and this is the only departure from perfect bilateral symmetry in the whole body of the animal. The alimentary canal is lined throughout with ciliated cells, and the vibration of these cilia is the means by which the minute bodies which serve the larva for food are drawn into the digestive cavity.

There are two pairs of delicate longitudinal muscles, *rs ri*, which are competent to draw back the ciliated velum into the cavity of the shell, when the animal at once sinks. The complete closure of the valves is effected, as in the adult, by an adductor muscle, *am*, the fibers of which pass from one valve to the other. But it is a very curious circumstance that this adductor muscle is not the same as that which exists in the adult. It lies, in fact, in the fore part of the body and on the dorsal side of the alimentary canal. The great muscle of the adult, fig. 3, *M*, on the other hand, lies on the ventral side of the alimentary canal and in the hinder part of the body. And as the muscles, respectively, lie on opposite sides of the alimentary canal, that of the adult can not be that of the larva, which has merely shifted its position; for in order to get from one side of the alimentary canal to the other it must needs cut through that organ; but as in the adult no adductor muscle is discoverable in the position occupied by that of the larva or anywhere on the dorsal side of the alimentary canal, while on the other hand there is no trace of any adductor on the ventral side in the larva, it follows that the dorsal or anterior adductor of the larva must vanish in the course of development, and that a new ventral or posterior adductor must be developed to play the same part and replace the original muscle functionally, though not morphologically.

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[a] Report Maryland Fish Commission, Annapolis, 1880, pp. 19–25, in part.

When the free larva of the oyster settles down into the fixed state, the left lobe of the mantle stretches beyond its valve, and, applying itself to the surface of the stone or shell to which the valve is to adhere, secretes shelly matter, which serves to cement the valve to its support. As the animal grows the mantle deposits new layers of shell over its whole surface, so that the larval shell valves become separated from the mantle by the new layers (plate IX, fig. 3, *S*), which crop out beyond their margins and acquire the characteristic prismatic and nacreous structure. The summits of the outer faces of the umbones thus correspond with the places of the larval valves, which soon cease to be discernible. After a time the body becomes convex on the left side and flat on the right; the successively added new layers of shell mold themselves upon it, and the animal acquires the asymmetry characteristic of the adult.[a]

The horny convex shell of the fry (plate IX, fig. 3, *L*) may be seen, for a considerable time after attachment, at the umbo or beak of the developing shell of the spat (plate IX, fig. 3, *S*). The under or attached valve of the latter at first conforms closely to the surface to which it has become attached, being usually flat, but afterwards, as a rule, becoming deep and strongly concave, through an upgrowing along the edges.

FIXATION, SET, OR SPATTING.

At the time of fixation the fry will, under proper conditions, attach itself by its left valve to any hard or firm body with which it may come in contact.

The first essential is that the surface should be clean and that it should remain so a sufficient length of time to enable the young oyster to establish itself firmly. So long as this condition obtains, the nature of the material seems to matter but little. In most bodies of water the spat fixes itself at all levels from the surface to the bottom, but in certain parts of the coast its place of attachment is confined to the zone between high and low water, the mid-tide mark being the place of maximum fixation. It has been suggested that this was due to the density of the water preventing the sinking of the fry. There are a number of objections to this theory, but no better one has been offered, and it may receive provisional acceptance.

GROWTH.

At the time of its attachment the oyster fry measures about one-eightieth or one-ninetieth of an inch in diameter. The valves of the shell are strongly convex and symmetrical, and are composed of a horny material quite different from the finished shell of the adult.

The mantle, a thin flap of tissue which envelops the body of the oyster on each side, projects freely from between the lips of the valves and is the organ which secretes the shell. Upon its outer surface suc-

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[a] Huxley, Thomas H.: Oysters and the Oyster Question. The English Illustrated Magazine, London, Oct., 1883, and Nov., 1883, vol. 1, pp. 47-55 and 112-121.

cessive layers of horny material are laid down, these becoming impregnated with calcareous matter arranged in a prismatic manner, and thus forming the stony shell which characterizes the adult.

The mantle increases *pari passu* with the growth of the soft parts in general, and as it is always capable of protrusion a little beyond the lips of the valves, it follows that each successive layer of shell is slightly larger than that which preceded it, and the shell increases in length and breadth as well as in thickness. From the nature of its growth, therefore, the youngest or newest part of the shell is on the inner face and at the edges, the latter always being sharp and thin in a growing oyster. The shell of the young oyster is always thin and delicate, and is generally more rounded than in the adult. The lower valve at first adheres closely to the body to which it is attached, but later its edge grows free and the valve, as a whole, becomes deeper and more capacious than its fellow. The small larval or fry shell remains visible at the beak of the spat shell for a considerable time, but becomes eroded away before the oyster reaches the adult condition.

The soft parts of the oyster assume their adult form in general soon after attachment, although the genital glands do not become functional until a much later period.

The rate of growth varies with locality and conditions. It is more rapid when food is abundant and at seasons when the oyster is feeding most vigorously, these conditions being filled most thoroughly in summer and fall, when the warm water increases the vital activities of both oyster and food.

In South Carolina oysters not more than six or seven months old were found to have reached a length of $2\frac{1}{2}$ inches, and in the warm sounds of North Carolina they reach a length of $1\frac{1}{2}$ inches in from two to three months. In the coves and creeks of Chesapeake Bay they attain about the same size by the end of the first season's active growth, and by the time they are 2 years old they measure from $2\frac{1}{2}$ to $3\frac{3}{4}$ inches long and from 2 to 3 inches wide. On the south side of Long Island the growth of the planted oysters is much more rapid than in Connecticut, it being stated that "two-year plants" set out in spring are ready for use in the following fall, while upon the Connecticut shore it would require two or three years to make the same growth. On the south side of Long Island oysters $1\frac{5}{8}$ inches long in May have increased to 3 inches by November of the same year.

The amount of lime in the water is a factor in determining the character of the shell, and oysters growing in waters deficient in that respect have thinner shells than those which are well supplied, and are therefore more susceptible to the attacks of the drill.

The shape of the oyster to a certain extent determines its value in the market. Single oysters of regular shape with deep shells and plump bodies will bring a better price than those which are irregular

and clustered. The shape depends largely upon the degree of crowding to which the oyster has been subject. When numerous spat become attached to a single piece of cultch, such as an oyster shell, there is often insufficient room for the development of all. Many will be crowded out and suffocated, while the survivors will be distorted through the necessity of conforming to the irregular spaces between the valves of their fellows. Sometimes the pressure exerted between the rapidly growing shells is sufficient to break up the more fragile forms of cultch, and the separated oysters then usually improve somewhat in shape.

The crowding of oysters reaches its climax upon the "raccoon" oyster beds. Raccoon oysters are usually found in localities where the bottom is soft and the only firm place which offers itself for the attachment of the spat is upon the shells of its ancestors. Temperature and other conditions are favorable, growth is rapid, the young oysters are crowded into the most irregular shapes, the shells are long, thin, and sharp edged, and eventually the mass of young is so dense that it crowds out and smothers the preceding generations which produced it and offered means for its attachment. Oysters crowded in this excessive manner are poor flavored as well as ill shaped, but both defects are corrected if they be broken apart, as may be readily done, and planted elsewhere.

OBSERVATIONS AND EXPERIMENTS ON THE GROWTH OF OYSTERS.

By O. C. Glaser.

INTRODUCTION.

One can hardly fail to be impressed with the great diversity in the shape of oysters on the natural beds. Normal disk-shaped and oval individuals lie side by side with those of irregular and even grotesque form, while here and there in vertical clusters are narrow shells of extreme length. These narrow and elongated shells, which in some places predominate to the almost entire exclusion of all other shapes, are important agents in the formation of reefs, marshes, and islands.

The elongated condition of these oysters has been attributed to various causes. According to one view, the complete exposure to the air at every low tide accounts for it, but this explanation is entirely inadequate. Not only is it difficult to understand how such exposure could bring about the great increase in length which these oysters have experienced without corresponding growth in width, but it completely fails to account for the fact that equally elongated individuals are found on beds that are always below watermark and can not receive any periodic exposure to the air.

According to another view, this shape of the oysters is due to the fact that they are half buried in mud, because, in order to escape suffocation, they elongate into the clearer strata of water above them. This explanation is apparently more credible than the first, but it has still greater difficulties to overcome. If the presence of mud were the factor determining the elongation of oysters it would be difficult to find any that are not elongated, and it would be useless to look for well-shaped oysters in many places from which we gather large and choice specimens for the market. It would also be useless to look for elongated forms on the reefs where they are now most abundant, because these reefs are almost entirely composed of shells and calcareous sand. That there is nothing in the general environment which effects the elongation of oysters is shown further by the fact that perfectly normal individuals grow on the elongated ones.

A third view attributes the elongated condition to crowding. Ryder, in his Contribution to the Life History of the Oyster, says that the natural tendency of oysters to grow upward accounts for the fact that they become crowded, and crowding makes them narrow and elongated. "In all the natural banks which I have had the pleasure of examining in the Chesapeake, the individual oysters assume an approximately vertical position. The assumption of this position seems perfectly natural. With the large end downward and the free edges of the valves directed upward the animals are in an excellent position to feed, while the outside vertical surfaces of the valves are well adapted to afford places of attachment for the spat. The habit of growing in the erect position, where the banks are prolific and undisturbed, causes the individuals to be very much crowded together, so that they do not have a chance to expand and grow into their normal shape. From this cause—overcrowding—the shells of the individual oysters become very narrow and greatly elongated. The peculiar forms which result are known to oystermen as 'raccoon oysters' or 'cat's tongues.'" Verrill, in his Vineyard Sound report, points out that old specimens in crowded beds often grow to be more than a foot long and, perhaps, only 2 inches wide. Professor Brooks, in his well-known book on the oyster, also thinks that the elongated forms are due to crowding: "The oysters are crowded together so closely that they can not lie flat, but grow vertically upward side by side. They are long and narrow, are fastened together in clusters, and are known as 'coon oysters.'" Dr. Caswell Grave, in his article on the oyster reefs of North Carolina (1901), believes that the oysters composing the clusters on the reefs are long and narrow on account of their crowded condition, and Dr. H. F. Moore, of the United States Fish Commission, in a personal communication, commits himself to the view "that the elongation of the oyster, tending to the raccoon type, is either due to crowding on the beds or to the attempt of the oyster to keep the lips of its shell above the surface of the soft bottom."

These opinions, with the exception of that of Moore, who thinks that the presence of mud may also be one of the reasons for the elongation, agree as to the cause of the shape of the oysters. Ryder thinks that the crowding is due to the natural tendency of oysters to grow upward. I have not been able to observe this natural tendency, and I believe with Professor Brooks that the crowding brings about the upward growth, and not the upward growth the crowding.

OBSERVATIONS.

Young oysters are frequently found covering shells, rocks, and other suitable material so completely that nothing can be seen of the objects to which they are attached. In such collections it is easy to see that

the proximity of the oysters to one another causes the thin growing margins of their shells to fuse and become folded upward. As they grow without any corresponding increase in the surface on which they have settled, those portions of the shells which have been made, after all the available surface has been used, become more and more raised, until finally the oysters are placed at a sharp angle to their original position. If growth continues they will finally be perpendicular to the surface of attachment.

Very frequently new spat settles on the shells which have been elevated, and if this new layer is sufficiently dense the shells again become crowded, misshaped, and elevated. If there were no irregularities in the shells to which they are attached they would ultimately stand at right angles to them. The first layer, however, presents so many openings and corners into which shells of the second layer may squeeze that these, instead of growing out at a sharp angle, usually are densely packed into the available crevices. In this way clusters are formed in which one may often count from five to seven generations. The oysters in these collections are nearly all misshaped or unduly elongated, and all such are oppressed on one or more sides by neighbors. Often the direction of growth is suddenly changed by a sharp angle and the edges of the shells follow even the minute indentations and irregularities of their neighbors. It seems clear from such clusters that the elongated and irregular shapes of the oysters are due to the fact that there is not room enough for them to expand and grow to the width which they might have attained had they been isolated or comparatively free.

One of the first facts to be noticed during a study of localities where elongated oysters grow is that normal adults occur frequently in the little bays and indentations of marshes, but are rare on the points, which are tipped with regions composed almost entirely of the elongated forms growing actively under an environment similar to that of the reef oysters. The oysters that grow in the marsh bays and inlets are surrounded by great quantities of mud, which is in part produced by decaying vegetable and other organic matter derived from the marsh itself, but probably is collected chiefly by the mass of green vegetation which acts as a sieve through which the water passes at high tide, parting with much of the matter that it holds in suspension. The mud thus collected accumulates, especially in the little bays and inlets, and after a heavy rain may rise several inches and smother a good many oysters which were on the surface of the old shore line. Sometimes the accumulation is very sudden and great. In making these observations on one occasion it was necessary to revisit, after some days, a certain little bay, and there I found a perfectly smooth and even muddy shore line, knee deep under which were the oysters I had come to examine.

From this it seems probable that the presence of mud, while it sacrifices many oysters, is good for those which survive, because they are freed from the crowding of neighbors. I suspect that the advantage of dragging a dredge over young beds not yet ready to yield a harvest, lies not only in the fact that in this way the clusters are forcibly separated, but that many young oysters, which would have grown to maturity and then crowded one another, are turned under and killed by the mud, giving their more fortunate neighbors a better opportunity for normal and regular growth.

The excessive crowding to which the oysters growing in clusters are subject has been held by Professors Brooks and Verrill to account for the fact that such collections, often numbering as many as 100, are frequently composed entirely of empty shells. The work of Doctor Grave on the conditions under which oysters feed lends strong support to the opinion that crowding may bring about the death of entire clusters, because it is almost certain that the individuals composing them are poorly fed, and therefore probably not so resistant as oysters growing alone or in less densely crowded communities. Doctor Grave has shown that under normal and favorable conditions a Newport River oyster takes one hour to strain 333 c. c. of water, and that it can obtain sufficient nutriment in from two to six hours. The thickest clusters of marsh and reef oysters are found where they are covered only during the last hour of flood tide, during slack water, and during the first hour of ebb tide, and in this brief period they must get their food. Thus the maximum time which many of these oysters have for feeding is little more than the minimum time during which their more fortunately situated relatives can procure all they need. The supply of food, shortened in this way by a disadvantageous position, is in all probability still further diminished as a direct result of the crowding. The density with which the elongated oysters are packed makes it almost certain that the water containing their food passes through more than one set of gills, and the amount that each individual can extract will depend on the number of times that the water has already been strained. Only the first oyster securing a given quantity of water has the opportunity of extracting from it all the diatoms that it contains.

While there seem to be good reasons for believing that the ill-nutrition and the crowding of oysters, caused by their location, may account for the fact that so many of them die, there is another possibility which must be taken into consideration in explaining the large numbers of clusters of empty shells. It is no rare occurrence for many of the animals inhabiting the sand flats to be killed at low tide by the great heat of the midsummer sun. There can be little doubt that the oysters also suffer during these periods of too high temperature, and it is very

probable that many of them, whether underfed or not, succumb. In the winter, also, exposure to too low a temperature may freeze them to death. These unfavorable temperatures surely occur with sufficient frequency to account in part for the great quantities of empty shells.

EXPERIMENTS.

I. *To ascertain whether normal oysters can be converted into elongated ones by pressure.*

Thirty round, well-shaped young oysters were removed from cultch taken from the experimental bed in Newport River. These oysters were fastened by means of Portland cement to slabs of slate and the cement was so piled up around them that each oyster was subject to pressure on two of its edges, the margin opposite the hinge being free. After the cement had hardened, the slabs were put in the water near the laboratory and left undisturbed for one month. At the end of this time they were removed and the oysters examined.

None had died, indicating that the abnormal conditions under which they had been placed were not unfavorable to life. None had grown in width, but all were longer than at the beginning. Some had the scolloped anterior edges characteristic of elongated oysters, and due probably to the fact that the laterally oppressed mantles, instead of spreading out flat and evenly, are thrown into folds. These results indicate that mechanical pressure may be an important factor in determining the shape of the shell.

II. *To ascertain whether elongated oysters liberated from an oppressive environment will change in shape.*

Thirty-five elongated and narrow young oysters were removed from their crowded condition, cleaned, and carefully measured. Their length was taken from the tip of the umbo of the upper valve to the middle of the anterior edge, and their width at a point on the same valve halfway between the two extremities of the first measurement. They were then placed in a cage made of galvanized iron wire, and this was suspended horizontally in the water under the laboratory wharf, where an especially strong tidal current prevails. After thirty, and again after forty-eight, days the above measurements were taken in the same way and compared with the initial figures. The results are given in the table following.

TABLE I.

August 2, 1902, initial measurement.			September 2, 1902, after thirty days.			September 18, 1902, after forty-eight days.		
Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.
Cm.	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*
4.2	2.1	50	2.9	2.1	72	4.9	3.7	76
6.6	3.0	45	2.7	2.1	78	5.7	2.6	46
3.7	1.9	51	4.6	3.1	67	4.2	2.1	50
5.0	2.1	42	5.8	3.0	52	4.0	2.3	58
4.0	1.5	38	2.4	2.2	92	3.7	2.6	70
4.0	2.3	58	3.3	2.0	61	6.0	3.0	50
3.5	1.9	54	3.6	2.5	69	5.4	3.3	62
5.9	2.6	44	4.0	2.2	55	3.8	2.0	53
3.4	1.9	56	4.1	2.4	59	4.9	2.9	57
3.6	2.5	69	4.1	2.1	51	3.2	2.8	88
3.8	1.9	50	3.6	2.0	56	5.0	3.3	66
4.2	1.8	43	3.0	2.0	67	4.1	2.5	61
3.6	1.9	53	5.1	2.5	49	5.2	2.8	54
2.2	1.2	55	4.2	2.5	60	7.1	3.6	51
3.0	1.7	57	5.0	3.0	60	3.4	2.9	85
2.5	1.1	44	3.9	2.9	74	2.9	2.9	100
2.6	1.9	73	3.7	2.4	65	4.2	3.1	74
3.2	1.2	38	3.8	3.0	79	4.6	2.8	61
4.0	2.1	53	3.5	2.3	65	4.5	3.0	67
3.3	1.8	55	3.1	1.9	61	4.5	3.0	67
3.2	1.8	56	3.5	1.9	54	4.0	3.0	75
4.2	2.2	52	4.3	2.8	65	3.4	2.4	71
3.0	1.4	47	3.8	2.3	61	4.3	3.5	81
3.1	1.4	45	5.0	2.9	58	4.2	2.4	57
2.0	.9	45	4.0	2.8	70	5.6	4.0	71
2.7	1.1	40	4.8	3.3	64	6.4	3.1	48
1.7	.9	53	4.1	3.1	76	5.4	4.0	74
2.8	1.9	68	4.6	2.3	50	4.2	3.3	79
2.4	1.5	63	3.6	2.2	61	3.6	2.2	61
2.5	1.4	56	6.7	3.1	46	4.3	2.9	67
2.6	1.8	69	3.6	2.3	64	4.0	2.7	68
2.9	1.5	52	6.2	3.1	50	4.1	2.7	66
3.8	2.1	55	3.0	2.0	67	4.2	2.5	60
2.3	1.2	52	(a)	(a)		(a)	(a)	
1.6	1.3	81	(a)	(a)		(a)	(a)	
Average ratio, 53.			Average ratio, 62.			Average ratio, 66.		

a Dead.

NOTE.—In taking the measurements and in calculating the percentage ratios of width to length decimals under 0.05 were neglected and 0.05 and over were counted as .1.

From this table it is evident that at the beginning of the experiment, August 2, 1902, the width of this lot of oysters was only 53 per cent of the length, whereas on September 2 it was 62 per cent, an increase of 9 per cent; on September 18 it was 66 per cent, an increase over the original ratio of 13 per cent. This marked change, easily noticeable without measurements, was very surprising because it took place in forty-eight days after the liberation of the oysters from their original oppressive environment.

To compare these oysters with the normally shaped ones from the experimental bed in Newport River, thirty young oysters from this locality were measured in the same way:

TABLE II.

Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.
Cm.	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*
3.1	2.9	94	3.3	3.3	100
5.0	3.5	70	4.6	3.6	78
2.3	1.8	78	4.8	3.5	73
2.9	3.0	103	5.4	3.5	67
4.8	3.0	63	3.6	2.8	78
4.9	3.7	76	2.8	2.6	93
5.4	3.3	61	5.0	2.9	58
5.0	4.2	84	3.5	2.5	71
4.1	3.0	76	5.6	3.9	70
5.0	3.6	72	3.7	3.3	89
5.7	4.3	75	4.8	3.7	77
4.2	3.6	86	4.0	3.6	90
5.7	4.0	70	3.5	2.8	80
5.5	3.8	69	2.5	3.0	120
4.0	3.1	78	2.4	2.0	83

Average ratio of width to length 79 per cent.

These measurements show that in some cases a young oyster is actually wider than it is long, and the occurrence of such makes the ratio of width to length very high. For the present lot it was 79 per cent.

The oysters used in Experiment II were, according to their size, of about the same age as the normal spat, and the two groups can therefore be compared. At the beginning the width of the experiment oysters was only 53 per cent of their length, or 26 per cent less than the similar relation in the normal spat. On September 2 it was 62 per cent, or 17 per cent below normal, and on September 18 it was 66 per cent, or 13 per cent below normal, showing a steady approximation to the condition found in oysters which have never been subject to crowding.

This comparison between the normal spat and the young elongated forms suggested a similar one between adults of normal shape and elongated oysters of about the same size and approximately the same age. The length and width of these were measured by the method employed with the younger oysters.

TABLE III.

Normal adults.			Elongated oysters.		
Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.
Cm.	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*
10.7	6.2	57	10.0	3.2	32
8.8	4.8	55	7.8	4.0	50
8.7	4.3	49	9.4	3.9	41
8.5	4.6	54	8.4	3.3	39
9.0	6.0	67	7.4	3.0	41
8.9	5.4	61	7.8	3.2	41
9.9	5.3	54	8.6	3.5	41
9.4	4.6	49	8.0	3.8	48
7.3	4.5	62	7.6	2.8	37
8.9	5.7	64	6.5	2.7	42
7.5	4.1	55	7.6	3.7	49
8.2	4.6	56	6.0	2.6	43
8.8	4.0	45	8.9	3.5	39
8.3	5.2	63	6.8	3.5	51
6.5	4.4	68	7.3	3.7	51
6.6	3.4	52	7.7	2.9	34
7.7	4.4	57	8.0	2.9	36
9.0	4.8	53	8.7	3.9	45
6.7	4.5	67	6.3	2.7	43
9.5	3.7	39	6.3	2.5	40
9.2	4.0	43	6.4	3.0	47
7.2	4.7	65	7.6	2.6	34
8.4	4.5	54	6.5	2.7	42
8.7	4.9	56	7.7	2.1	27
7.7	4.3	56	8.1	2.3	28
8.8	4.8	55	7.0	3.4	49
10.0	5.2	52	6.5	2.9	44
6.2	4.0	64	7.6	3.1	41
8.1	4.8	59	8.3	3.8	46
8.0	4.3	54	6.3	2.4	38
Average ratio, 56.			Average ratio, 41.		

These measurements illustrate very strikingly that oysters normally grow longer than they do wide, so that a large, well-shaped adult oyster may, in the relation between its width and its length, give a figure far below the one expressing the same relation in younger stages.

At first glance it might possibly be thought that the adult "normal" oysters were not normal at all, because their width was only 56 per cent of their length, being 13 per cent lower than the ratio between the width and length of the young spat referred to in Table II. This, however, is by no means the case, because the relation between width and length varies with the age. An old "normal" oyster is not a "good" oyster; thus the interesting fact is brought to light that a condition which normally occurs only in oysters of extreme old age may be induced in young ones by crowding. As far as the relations between width and length are concerned, therefore, young elongated oysters are in a state of premature old age. Verrill long ago pointed out that great increase in length without corresponding growth in width is the natural order of things. "Nearly all the oyster shells composing the ancient Indian shell heaps along our coast are of this much elongated kind. Nowadays the oysters seldom have a chance to grow to such a good old age as to take on this form, though such are occasionally met with in deeper water." Such mounds as Profes-

sor Verrill mentions occur at Marshallsburg, N. C., and there this kind of oyster shell is extremely abundant. The same type of shell, commonly known as the "razor blade," is also found, sometimes with the animal still alive, on the shores of the Newport River marshes.

III.—*To ascertain whether the recuperative power of elongated oysters varies with their age.*

Experiment II clearly demonstrates the fact that oysters grown under oppressive conditions are capable of changing in shape and assuming ultimately a form normal for their age. It is desirable, however, to know how late in life an oyster is still able to take advantage of new opportunities, and for this purpose the following experiment was made:

Ninety oysters were liberated from the most oppressive surroundings and were divided roughly, according to length, into three lots - (A) containing all sizes up to and slightly over an inch, (B) sizes between 1 and 2 inches, and (C) all measuring 3 inches or more in length. These three lots were measured, as in experiment II, and then placed in separate galvanized iron wire cages which were suspended horizontally under the wharf, as in the former experiment. They were placed in the water on September 5, 1902, and removed on November 5. The measurements were as follows:

TABLE IV.

SEPTEMBER 5, 1902.

A			B			C		
Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.
Cm.	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*
4.7	2.1	45	5.4	3.0	56	10.0	3.2	32
3.6	2.0	56	4.6	1.9	41	7.8	4.0	50
4.6	1.9	41	5.7	1.6	28	9.4	3.9	41
2.6	1.3	50	5.6	2.5	45	8.4	3.3	39
4.8	2.2	46	5.5	1.9	35	7.4	3.0	41
2.3	1.5	65	5.4	2.5	46	7.8	3.2	41
3.7	1.9	51	5.0	2.0	40	8.6	3.5	41
3.0	1.4	47	5.5	2.1	38	8.0	3.8	48
3.9	2.2	56	5.8	2.7	48	7.6	2.8	37
2.7	1.2	44	5.4	3.1	57	6.5	2.7	42
3.9	2.2	56	4.7	2.9	62	7.6	3.7	49
2.1	1.1	53	7.0	2.5	36	6.0	2.6	43
3.3	1.3	39	5.3	1.7	32	8.9	3.5	39
4.1	1.8	44	4.6	2.1	46	6.8	3.5	51
2.9	1.2	41	4.8	2.0	42	7.3	3.7	51
3.5	1.5	43	5.5	2.4	44	7.7	2.6	34
4.3	2.2	51	4.8	2.2	46	8.0	2.9	36
3.3	2.1	64	5.3	2.7	51	8.7	3.9	45
3.8	1.9	50	5.4	2.3	43	6.3	2.7	43
3.0	1.8	60	5.2	2.4	46	6.3	2.5	40
3.1	1.4	45	5.0	2.3	46	6.4	3.0	47
4.8	2.0	42	4.6	2.7	59	7.6	2.6	34
2.2	1.0	45	5.1	1.8	35	6.5	2.7	42
3.8	1.9	50	4.8	2.0	42	7.7	2.1	27
2.1	1.4	67	6.2	2.6	42	8.1	2.3	28
3.7	1.6	43	5.2	1.7	33	7.0	3.4	49
3.7	1.7	46	5.6	2.1	38	6.5	2.9	44
4.3	2.1	49	5.4	2.5	46	7.6	3.1	41
3.0	1.3	43	5.5	2.6	47	8.3	3.8	46
3.0	1.6	53	5.0	2.2	44	6.3	2.4	38
Average ratio, 50.			Average ratio, 41.			Average ratio, 41.		

NOVEMBER 5, 1902.

A			B			C		
Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.	Length.	Width.	Ratio of width to length.
Cm.	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*	*Cm.*	*Cm.*	*Per cent.*
4.2	2.8	67	5.8	3.3	57	6.9	3.2	46
4.6	3.5	76	6.6	3.9	59	9.0	3.8	42
4.0	2.8	70	4.4	2.7	61	6.7	3.7	55
4.5	2.9	64	7.1	3.6	51	7.4	3.8	51
3.6	2.8	78	6.2	3.0	48	7.6	3.6	47
4.5	2.9	67	5.9	3.5	59	8.6	4.3	50
4.3	2.5	58	6.0	3.4	57	8.6	4.3	50
3.1	2.3	74	5.8	2.9	50	8.3	3.8	46
4.8	3.1	65	5.5	2.5	45	8.2	4.0	49
3.1	2.3	74	6.2	3.1	50	6.6	3.3	50
5.5	2.9	53	6.0	3.3	55	7.3	3.6	49
4.2	2.7	64	5.5	2.7	49	7.6	3.2	42
5.7	3.3	58	6.3	3.4	54	7.3	3.9	53
4.3	3.0	70	5.8	3.8	66	7.9	3.4	43
4.1	2.5	61	5.8	2.7	47	9.5	4.2	44
3.0	2.5	83	5.4	2.9	54	7.9	3.3	42
3.1	2.5	81	7.1	3.3	46	8.1	3.1	38
5.6	3.3	59	5.9	3.1	53	7.7	4.0	52
3.3	2.2	67	5.8	2.9	50	7.9	4.3	54
5.0	3.3	66	5.1	3.4	67	8.3	2.9	35
4.0	2.7	68	6.3	3.3	52	6.6	2.9	44
5.8	3.7	64	6.1	3.7	61	7.4	4.0	54
4.5	3.1	69	5.7	3.0	53	6.3	3.2	51
4.8	2.7	55	(a)	(a)		6.4	3.4	53
3.7	2.4	65	(a)	(a)		(a)	(a)	
4.6	3.4	74	(a)	(a)		(a)	(a)	
3.9	2.4	62	(a)	(a)		(a)	(a)	
4.6	2.6	57	(a)	(a)		(a)	(a)	
(a)	(a)		(a)	(a)		(a)	(a)	
(a)	(a)		(a)	(a)		(a)	(a)	
Average ratio, 68.			Average ratio, 54.			Average ratio, 47.		

a Dead.

The oysters in lot A were of the same age as those used in experiment II, and a comparison of the measurements of the two groups fully corroborates the earlier results. The final measurements of lot A were made two months after the oysters had been liberated, and show more strikingly than the former experiment that elongated oysters are capable of approaching a normal shape with surprising rapidity. Two photographs were taken of this particular lot (plate x), and these illustrate as forcibly as the figures the great change that took place.

A comparison of the initial and final measurements of lots A, B, and C also shows that the recuperative power varies with age. On September 5 the ratio of width to length was 50 per cent in lot A, 44 per cent in lot B, and 41 per cent in lot C, whereas on November 5 the same lots presented respectively a percentage of width to length of 68, 54, and 47 per cent. Thus in all an improvement in the relation between width and length took place, lot A increasing 18 per cent, lot B 10 per cent, and lot C 6 per cent. This gradation is just what would be expected from the fact that oysters approaching old age normally grow longer than they do wide.

Of the oysters used in this experiment lots A and C, on account of

LOT A (EXPERIMENT III) AT BEGINNING OF EXPERIMENT, SEPTEMBER 5, 1902. (THREE-TENTHS NATURAL SIZE.)

LOT A (EXPERIMENT III) AT END OF EXPERIMENT, NOVEMBER 5, 1902. (THREE-TENTHS NATURAL SIZE.)

their original size, can be compared with the spat and normal oysters of Tables II and III. Such a comparison of the percentage ratios in the three tables shows that at the beginning lot A was 29 per cent below normal and lot C 15 per cent below normal, whereas after 60 days of improved surroundings lot A was only 11 per cent below normal and lot C 9 per cent below normal, demonstrating that the recuperative power of lot A was exactly three times that of lot C.

Without attaching too much weight to the results, it is interesting to note in what time these two lots A and C would have reached the normal states for their respective ages, if the rates of growth had continued what they were during the sixty days of the experiment. In lot A, in sixty days, the relation between the width and the length changed from 50 to 68 per cent, an average daily change of three-tenths per cent. According to Table II the normal condition is 79 per cent, from which it follows that at the rate of three-tenths per cent change per day, it would have taken this lot of oysters ninety-seven days (probably less, because at the age then attained the normal would be less than 79 per cent) to make up the discrepancy between 50 and 79 per cent. In lot C, on the other hand, the relation between the width and the length changed in sixty days from 41 to 47 per cent, a daily change of one-tenth per cent. According to Table III, the normal for this age is 56 per cent, from which it follows that at the rate of change of one-tenth per cent per day, lot C would have taken one hundred and fifty days to attain a normal condition. The recuperative power of the younger oysters is so much greater than that of the older ones, that in spite of the fact that they are much further below normal, they are nevertheless capable of realizing this condition in much less time.

The young oysters, besides having the advantage over the older ones of possessing greater recuperative power, seem also to possess greater resistance to the ill effects almost certainly attendant on a sudden change of environment. Not enough cases have been noted, of course, to establish this fact with a great degree of certainty, but a glance at Table IV will show that the mortality in lots B and C respectively was 23 and 20 per cent while it was only 7 per cent in lot A.

CONCLUSIONS.

The elongated condition which many oysters exhibit before they have attained old age is due to crowding. A great increase in length without an apparently proportionate increase in width represents the normal growth of an oyster, and the so-called "razor blades," much narrower than many of the elongated marsh and reef oysters, exhibit this condition, not because they have grown under unfavorable conditions, but because they are old. The elongated oysters which have been considered in this paper are young, and their shape is abnormal.

Because they have the same forms and proportions of much older normal oysters they may be said to be in a state of premature old age.

The crowded condition of these prematurely old oysters makes it impossible for them to expand and grow to a width normal for their age. They have the power to expand, however, when removed from this crowded condition, and this expansion takes place so rapidly that for the periods during which they were under observation they grew more in width than in length. This is exactly what happens in very young oysters that have settled where they have abundant room. Under such favorable conditions the growth in width, for a period at least, is equal to the growth in length, and at times the former measurement may even exceed the latter. After this period in early youth the growth in width steadily decreases until the oyster reaches old age. Under unfavorable crowded conditions the growth in width is inhibited immediately after the period during which it is equal to or greater than the growth in length. If the hindrance is removed, a growth in width exceeding the growth in length nevertheless takes place. It seems as though the shell made up the loss which is the result of the crowding.

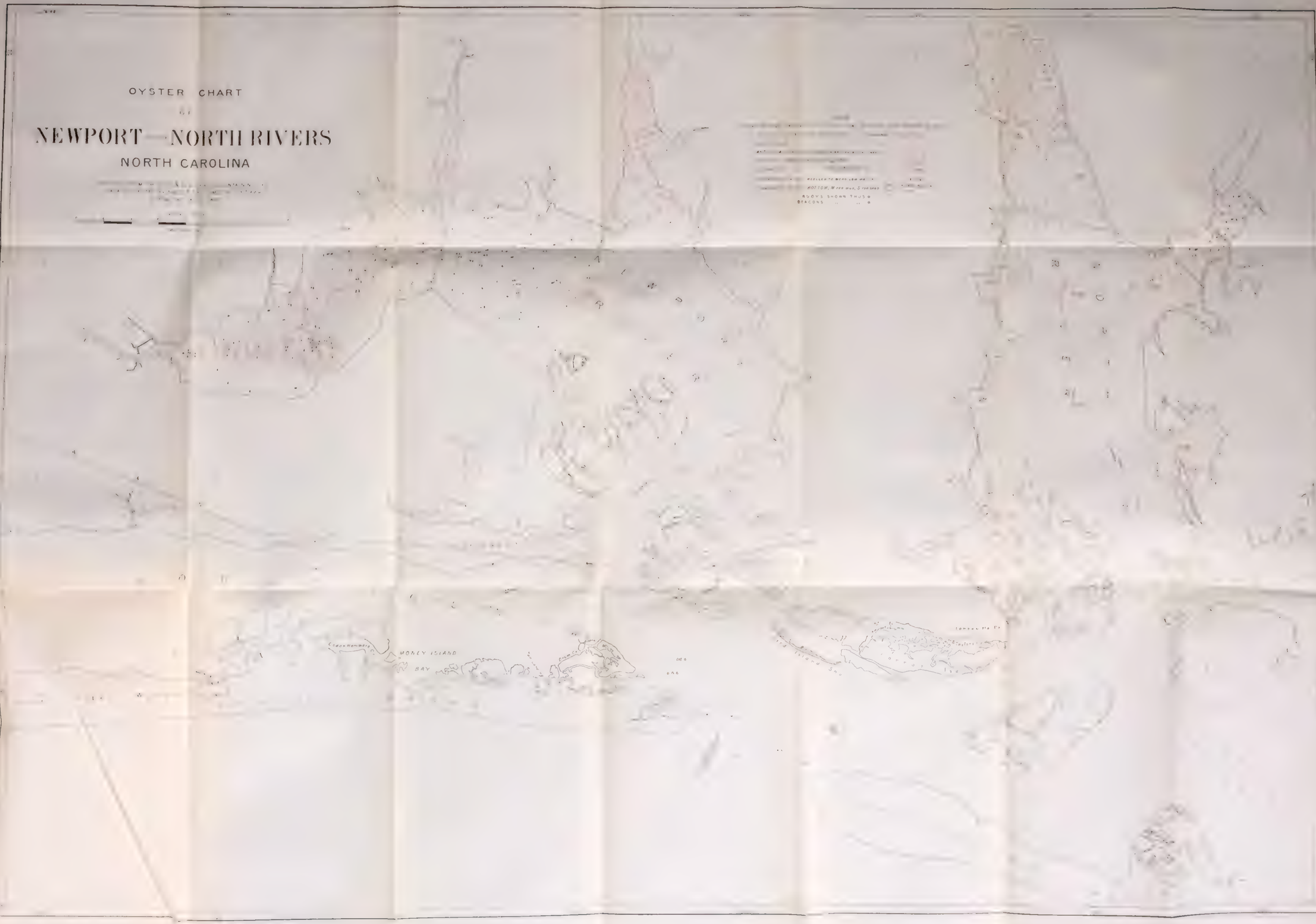
If we were to represent the normal growth in length and width by two curves, the width curve would, in the beginning, rise to the same or to a greater height than the length curve, but as the shell grew older the width curve would descend and the length curve rise until the original condition was reversed. In the elongated oysters, the width curve would have an early rise corresponding to the rise in the normal width curve, then a sudden fall, and, after isolation, another rise which would not be found in the normal curve. After this second rise the width curve would descend and correspond, in all probability, to the normal width curve for corresponding ages. The length curve of the elongated oysters would probably correspond stage for stage with the normal length curve, because the elongated oysters owe their condition, not to excessive length, but to excessive narrowness.

The recuperative power of oysters that have lived under oppressive conditions varies with their age. Young individuals recover much more rapidly than old ones, though these too improve to a marked degree. The latter, however, seem less able to adapt themselves to a sudden and violent change of environment, and the mortality among them is much greater than among younger ones.

These facts have a decided economic bearing. The experience of oystermen, in Northern waters especially, has shown that oysters can be transplanted with great profit. At present millions of young spat settle on the shells fringing the marshes and reefs, and there, under unfavorable conditions, grow into the elongated forms which have no market value. In this paper evidence is brought forward which shows that these oysters, when separated from the oppressive conditions

under which they have grown, are able to recover and assume normal shapes.

The advantages which this class of seed offers to planters are its cheapness and the fact that the oysters are older and larger than those ordinarily used for planting. The most promising size is between 1 and 2 inches in length. After separation the oysters should not be left where they became crowded, but should be transplanted to properly located natural or artificial beds. There they will have favorable conditions of food, and in addition will be free from the danger of again becoming crowded, as the number of spat that settles on shells in wisely chosen localities is very much less than that which settles and continues to exist on the shells of the marshes and reefs.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NORTH CAROLINA
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MONEY ISLAND
BAY

STATISTICS OF THE FISHERIES OF THE SOUTH ATLANTIC STATES, 1902.

PREPARED IN THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES, UNITED STATES FISH COMMISSION.

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Assistant in Charge.

STATISTICS OF THE FISHERIES OF THE SOUTH ATLANTIC STATES, 1902.

The coast fisheries of North and South Carolina, Georgia, and the east coast of Florida were canvassed by statistical agents of the United States Fish Commission in 1903. The data obtained, which pertain to the calendar year 1902, have already been published in Statistical Bulletin No. 149, but are here given in more detail with explanatory text.

The number of persons engaged in the fisheries of the South Atlantic States in 1902 was 23,452, of whom 1,653 were on vessels engaged in fishing, 448 on vessels transporting fishery products, 15,610 on boats in the shore fisheries, and 5,741 in oil and guano works, oyster canneries, wholesale fishery trade, and other industries connected with the fisheries. By states the number of persons thus employed was as follows: North Carolina, 14,755; South Carolina, 3,713; Georgia, 2,286; the east coast of Florida, 2,698.

The total amount of capital invested as shown by this canvass was $2,991,149. In North Carolina the investment was $1,973,441; in South Carolina, $320,723; in Georgia, $342,150; and in Florida, $354,835. The number of vessels in the fisheries of this section, including transports, was 526, valued at $392,661; their net tonnage was 5,740 tons, and the value of their outfit was $85,095. The number of boats in the shore fisheries was 9,714, valued at $349,770. The apparatus of capture used on vessels and boats was valued at $691,728, the shore and accessory property at $833,395, and the cash capital used in the shore-fishery industries amounted to $638,500. The more important forms of fishing apparatus employed were seines, 1,310 in number, valued at $104,291; gill nets, 109,548, valued at $319,170; pound nets and weirs, 2,990, valued at $229,920; and tongs, dredges, rakes, etc., used in the oyster and clam fisheries, valued at $20,699.

The products of the fisheries in 1902 aggregated 106,446,072 pounds, valued at $2,839,633. The yield in North Carolina was 67,584,734 pounds, valued at $1,739,661; in South Carolina 8,174,463 pounds, valued at $263,023; in Georgia 11,102,610 pounds, valued at $359,081; and on the east coast of Florida 19,584,265 pounds, valued at $477,868. The species secured in largest quantities were alewives, fresh and salted, 11,601,172 pounds, $118,258; cat-fish, 1,310,392 pounds, $30,976; croak-

ers, fresh and salted, 1,991,053 pounds, $40,021; menhaden, 18,862,000 pounds, $31,420; mullet, fresh and salted, 14,310,808 pounds, $256,348; shad, 9,849,338 pounds, $605,539; Spanish mackerel, 1,013,172 pounds, $54,322; trout, or squeteague, fresh and salted, 4,848,269 pounds, $190,380; striped bass, 1,187,700 pounds, $114,574; clams, 1,415,440 pounds or 176,930 bushels, $100,752; oysters, 22,719,074 pounds or 3,245,582 bushels, $644,478; shrimp and prawn, 3,810,641 pounds, $86,640, and blue-fish, fresh and salted, 1,057,642 pounds, $37,856. Other important species, taken in smaller quantities, were black bass, 948,235 pounds, $70,524; bream and sun-fish, 660,514 pounds, $14,685; drum, 583,394 pounds, $14,453; eels, 512,411 pounds, $20,068; white perch, 945,050 pounds, $62,786; pompano, 289,821 pounds, $23,300; sea bass, 873,095 pounds, $36,420; sheepshead, 635,830 pounds, $18,285; spot, fresh and salted, 926,946 pounds, $21,425; whiting, 866,355 pounds, $39,778, and hard and soft crabs, 385,707 pounds, $18,950.

The fisheries of the South Atlantic States since 1897—the year for which the last previous canvass was made—have increased 6,267, or 36.46 per cent, in the number of persons employed; $1,162,317, or 63.55 per cent, in the amount of capital invested; and 26,055,607 pounds, or 32.41 per cent, in the quantity, and $1,006,478, or 54.90 per cent, in the value, of the products. These increases were shared in varying proportions by all the states of this region, but the percentage was largest in the fisheries of Florida.

The results of previous investigations of the fisheries of these states are given in the following publications:

The Fishery Industries of the United States, Section II, Geographical Review of the Fisheries for 1880.

The Fishery Industries of the United States, Section V, History and Methods of the Fisheries.

Report on the Fisheries of the South Atlantic States, by Hugh M. Smith. Bulletin U. S. Fish Commission, 1891, pp. 267–356.

The Fish and Fisheries of the Coastal Waters of Florida. Report U. S. Fish Commission for 1896, pp. 263–342.

Report on the Fisheries of Indian River, Florida. Report U. S. Fish Commission for 1896, pp. 223–262.

Notes on the Extent and Condition of the Alewife Fisheries of the United States in 1896, by Hugh M. Smith. Report U. S. Fish Commission for 1898, pp. 31–43.

The Shad Fisheries of the Atlantic Coast of the United States, by Charles H. Stevenson. Report U. S. Fish Commission, 1898, pp. 101–269.

Statistics of the Fisheries of the South Atlantic States. Report U. S. Fish Commission for 1899, pp. 171–227.

The following summarized tables give the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of the South Atlantic States

in 1902, and also a comparison of the extent of the fisheries in 1897 and 1902:

Table showing the number of persons engaged in the fisheries of the South Atlantic States in 1902.

States.	Fishermen.	Shoresmen.	Total.
North Carolina	11,592	3,163	14,755
South Carolina	2,178	1,535	3,713
Georgia	1,674	612	2,286
Florida	2,267	431	2,698
Total	17,711	5,741	23,452

Table showing the investment in the fisheries of the South Atlantic States in 1902.

Items.	North Carolina.		South Carolina.		Georgia.		Florida.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels	387	$310,381	25	$21,450	105	$52,950	9	$7,880	526	$392,661
Tonnage	3,941		340		1,340		116		5,740	
Outfit		50,623		6,282		26,035		2,155		85,095
Boats	6,472	222,151	1,106	34,335	736	21,574	1,400	71,710	9,714	349,770
Seines	965	85,458	61	2,320	139	5,236	145	11,277	1,310	104,291
Gill nets	107,191	236,855	229	13,495	347	10,385	1,781	58,435	109,548	319,170
Pound nets and weirs	2,982	228,610			7	1,260	1	50	2,990	229,920
Fyke nets	181	925							181	925
Cast nets			130	650	139	695	125	693	394	2,038
Lines		143		1,577		669		560		2,949
Pots	3,512	3,359							3,512	3,359
Dredges	407	7,249	4	42					411	7,291
Tongs, rakes, hoes, and grabs		7,753		1,351		3,434		867		13,408
Wheel and slides	37	775							37	775
Other apparatus		2,634						4,968		7,602
Shore and accessory property		579,475		86,518		86,912		80,490		833,395
Cash capital		237,050		152,700		133,000		115,750		638,500
Total		1,973,441		320,723		312,150		351,835		2,991,149

Table showing the quantity and value of products taken in the fisheries of the South Atlantic States in 1902.

Species.	North Carolina.		South Carolina.	
	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	3,171,975	$32,548		
Alewives, salted	8,001,000	83,664		
Amber-fish			5,000	$150
Black bass	632,675	58,013		
Blue-fish, fresh	904,942	32,200	1,000	40
Blue-fish, salted	72,200	2,068		
Bonito	3,206	32		
Bream and sun-fish	14,800	434		
Butter-fish	83,218	1,357		
Cat-fish	404,600	11,971	500	15
Cero and king-fish	45,380	455		
Channel bass or red-fish	144,339	1,961	102,000	3,550
Crevalle	13,900	164		
Croaker, fresh	1,908,635	37,620	27,000	610
Croaker, salted	20,000	700		
Drum	66,970	1,118	75,200	1,396
Eels	507,111	19,962		
Flounders	261,762	5,256	1,900	66
German carp	46,509	2,116		
Groupers			41,000	1,025
Hickory shad	684,896	33,552	30,600	1,416
Jew-fish			79,500	3,738
Menhaden	18,862,000	31,420		

Table showing the quantity and value of products taken by the fisheries of the Soute Atlantic States in 1902—Continued.

Species.	North Carolina.		South Carolina.	
	Lbs.	Value.	Lbs.	Value.
Mullet, fresh	3,258,906	$76,901	138,600	$3,782
Mullet, salted	3,446,586	110,742		
Perch, white	941,050	62,666		
Perch, yellow	105,992	5,639		
Pig-fish or hog-fish	191,670	6,677		
Pike	30,850	1,487		
Pompano	19,590	965	5,000	500
Porgy	16,800	269		
Sailor's choice and pin-fish	36,476	528	7,800	312
Sea bass	57,250	1,929	709,545	27,364
Shad	6,566,724	384,808	434,133	20,782
Sharks			90,000	1,800
Sheepshead	154,929	7,303	26,650	1,082
Snapper, red			10,100	303
Snappers, other	9,500	213	25,000	640
Spanish mackerel	354,084	19,948		
Spot, fresh	663,895	12,732	21,800	484
Spot, salted	208,800	7,384		
Squeteague, fresh	3,579,306	149,996	85,700	3,059
Squeteague, salted	202,150	6,251		
Strawberry bass	2,000	60		
Striped bass	1,175,400	113,631	9,800	768
Sturgeon	134,125	7,473	83,950	3,736
Caviar	10,580	7,874	10,200	5,410
Suckers	169,350	4,899		
Tautog	2,650	53		
Whiting and king-fish	120,480	3,395	605,300	30,118
Other fish	42,515	1,189		
Clam, hard	1,175,176	86,662	225,064	12,940
Crab, hard	3,000	100	96,200	995
Crab, soft	200,441	14,553		
Frogs	5,990	599		
Oyster	7,159,691	268,363	4,827,900	118,460
Prawn			3,000	150
Scallop	13,020	980		
Shrimp	84,160	2,700	366,500	12,452
Terrapin	30,780	11,042	27,521	5,850
Turtles	11,800	588		
Refuse fish	1,548,900	2,451		
Total	67,584,734	1,739,661	8,174,463	263,023

Species.	Georgia.		Florida.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	22,500	$450	405,697	$1,596	3,600,172	$34,594
Alewives, salted					8,001,000	83,664
Amber-fish					5,000	150
Angel-fish			4,550	71	4,550	71
Barracuda			1,000	50	1,000	50
Black bass	1,250	62	314,310	12,449	948,235	70,524
Blue-fish, fresh			79,500	3,548	985,442	35,788
Blue-fish, salted					72,200	2,068
Bonito			7,120	212	10,326	244
Bream and sun-fish	2,200	102	643,514	14,149	660,514	14,685
Butter-fish					83,218	1,357
Cat-fish	288,550	6,838	616,742	12,152	1,310,392	30,976
Cero and king-fish			31,790	318	77,170	773
Channel bass or red-fish	34,900	1,607	114,635	3,175	395,874	10,293
Crevalle			5,900	95	19,800	259
Croaker, fresh	28,825	870	6,593	191	1,971,053	39,321
Croaker, salted					20,000	700
Drum	25,100	1,006	20,250	640	187,520	4,160
Eels	5,300	106			512,411	20,068
Flounders	2,600	69	49,380	1,392	315,642	6,783
German carp	50,000	1,500			96,509	3,616
Groupers	50,000	1,500	26,910	486	117,910	3,011
Grunts			33,442	755	33,442	755
Hickory shad	1,800	90	58,666	2,651	775,962	37,709
Jew-fish					79,500	3,738
Menhaden					18,862,000	31,420
Mullet, fresh	125,800	2,576	7,340,916	62,347	10,864,222	145,606
Mullet, salted					3,446,586	110,742
Mutton-fish			4,740	96	4,740	96
Perch, white	4,000	120			945,050	62,786
Perch, yellow					105,992	5,639
Permit			10,342	254	10,342	254

Table showing the quantity and value of products taken in the fisheries of the South Atlantic States in 1902—Continued.

Species.	Georgia.		Florida.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pig-fish or hog-fish			1,800	$28	193,470	$6,705
Pike	350	$18			31,200	1,505
Pompano			265,231	21,835	289,821	23,300
Porgy			5,300	159	22,100	428
Sailor's choice and pin-fish			43,583	831	87,859	1,671
Sea bass	76,500	6,082	29,800	1,045	873,095	36,420
Sergeant-fish			2,828	43	2,828	43
Shad	1,029,050	75,189	1,819,431	124,760	9,849,338	605,539
Sharks					90,000	1,800
Sheepshead	50,000	2,500	404,251	7,400	635,830	18,285
Snapper, red	125,000	7,500	20,000	400	155,100	8,203
Snappers, other			8,043	124	42,543	977
Spanish mackerel			659,088	34,374	1,013,172	54,322
Spot, fresh			32,451	825	718,146	14,041
Spot, salted					208,800	7,381
Squeteague, fresh	82,550	4,107	898,563	26,967	4,646,119	184,129
Squeteague, salted					202,150	6,251
Strawberry bass			221,606	5,166	223,606	5,226
Striped bass	2,500	175			1,187,700	114,574
Sturgeon					218,075	11,209
Caviar					20,780	13,281
Suckers					169,350	4,899
Tautog					2,650	53
Whiting and king-fish	57,425	2,608	82,150	3,657	866,355	39,778
Yellow-tail			1,366	21	1,366	21
Other fish					42,515	1,189
Alligator hides			100,687	13,538	100,687	13,538
Clam, hard	10,000	825	5,200	325	1,415,440	100,752
Crab, hard	80,000	3,150	6,066	152	185,266	4,397
Crab, soft					200,441	14,553
Frogs					5,990	599
Otter skins			2,927	17,352	2,927	17,352
Oyster	8,568,000	220,467	2,163,483	37,188	22,719,074	644,478
Periwinkles			5,400	120	5,400	120
Prawn	276,000	5,750	3,012,360	62,896	3,291,360	68,796
Scallop					13,020	980
Shrimp	68,127	2,658	494	34	519,281	17,844
Terrapin	33,308	11,136	3,940	1,164	95,549	29,192
Tortoise shell			20	50	20	50
Turtle	975	20	12,200	787	24,975	1,395
Refuse fish					1,548,900	2,451
Total	11,102,610	359,081	19,581,265	477,868	106,446,072	2,839,633

Supplementary table showing certain of the foregoing products in number and bushels.

Products.	North Carolina.		South Carolina.		Georgia.		Florida.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alligator hides ..no..							22,375	$13,538	22,375	$13,538
Clam ....bush..	146,897	$86,662	28,133	$12,940	1,250	$825	650	325	176,930	100,752
Crab, hard........no..	9,000	100	288,600	995	240,000	3,150	18,198	152	555,798	4,397
Crab, soft.........no..	601,323	14,553							601,323	14,553
Frogs.............no..	11,980	599							11,980	599
Otter skins ......no..							2,927	17,352	2,927	17,352
Oyster.........bush..	1,022,813	268,363	689,700	118,460	1,224,000	220,467	309,069	37,188	3,245,582	644,478
Scallop ....no..	2,170	980							2,170	980
Terrapin ....no..	15,390	11,042	34,480	5,850	15,384	11,136	1,480	1,164	66,734	29,192

Comparative table showing the extent of the fisheries of the South Atlantic States in 1897 and 1902.

States.	Persons engaged. 1897.	Persons engaged. 1902.	Increase in 1902 compared with 1897. Number.	Increase in 1902 compared with 1897. Percentage.	Capital invested. 1897.	Capital invested. 1902.	Increase in 1902 compared with 1897. Amount.	Increase in 1902 compared with 1897. Percentage.
North Carolina	12,045	14,755	2,710	22.49	$1,218,459	$1,973,441	$754,982	61.96
South Carolina	2,139	3,713	1,574	73.58	174,354	320,723	146,369	83.94
Georgia	1,869	2,286	417	22.31	284,864	342,150	57,286	20.10
Florida	1,132	2,698	1,566	138.33	151,155	354,835	203,680	134.74
Total	17,185	23,452	6,267	36.46	1,828,832	2,991,149	1,162,317	63.55

States.	Products. Pounds. 1897.	Pounds. 1902.	Increase in 1902 compared with 1897. Amount.	Increase in 1902 compared with 1897. Percentage.	Value. 1897.	Value. 1902.	Increase in 1902 compared with 1897. Amount.	Increase in 1902 compared with 1897. Percentage.
North Carolina	64,234,257	67,584,734	3,350,477	5.21	$1,316,017	$1,739,661	$423,644	32.19
South Carolina	5,280,446	8,174,463	2,894,017	54.80	210,456	263,023	52,567	24.97
Georgia	4,993,100	11,102,610	6,109,510	122.35	170,605	359,081	188,476	110.47
Florida	5,882,662	19,584,265	13,701,603	232.91	136,077	477,868	341,791	251.17
Total	80,390,465	106,446,072	26,055,607	32.41	1,833,155	2,839,633	1,006,478	51.90

FISHERIES OF NORTH CAROLINA.

North Carolina still holds the lead among the South Atlantic States in extent of the fisheries, the number of persons employed and the value of the output being more than twice as great as for the remaining states combined. In 1902 the persons employed in the various branches numbered 14,755, while for all the remainder of the South Atlantic coast the number was only 8,697. The value of the vessels, boats, apparatus of capture, shore property, etc., amounted to $1,973,441 in North Carolina, and to $1,017,708 in the remaining states; the value of the catch was $1,739,661, while for South Carolina, Georgia, and the eastern coast of Florida combined it was $1,099,972.

Compared with the returns for 1897 the fisheries of North Carolina show a gratifying increase. The number of persons employed rose from 12,045 in 1897 to 14,755 in 1902; the value of the vessels, boats, apparatus, etc., from $1,218,459 to $1,973,441, and the catch from 64,234,257 pounds, worth $1,316,017 to 67,584,734 pounds, worth $1,739,661.

The large increase in value of the catch, amounting to 32 per cent, is due not so much to the extension of any particular branch of the fisheries as to an increase in the value per pound. Excluding menhaden,

which are used for fertilizer, the food fish in 1897 sold for an average of less than $2\frac{1}{2}$ cents per pound, whereas in 1902 the average selling price was $3\frac{1}{2}$ cents per pound.

Shad is the principal species, the yield in 1902 amounting to 6,566,724 pounds, worth $384,808; in 1897 the catch was 8,963,488 pounds, worth $362,811, and in 1890, 5,768,413 pounds, worth $306,015. In value of this product North Carolina outranks every other state.

The yield of oysters shows an increase from 858,818 bushels in 1897 to 1,022,813 bushels in 1902, but the value has not increased correspondingly, the average price having fallen from 28 cents to 26 cents per bushel. Oyster canning is a very important branch of the industry; in 1902, 503,220 bushels—nearly 50 per cent of the total catch—were delivered to canning establishments. Very little attention is now devoted to oyster culture, owing to the failure of the many attempts made. The yield of quahogs, or hard clams, has increased from 117,226 bushels in 1897 to 146,897 bushels in 1902, and the average price per bushel has advanced from 46 cents to 60 cents. The quality of the quahog catch is constantly improving, and thousands of bushels are now canned or shipped to northern markets.

The menhaden industry of North Carolina is of much greater extent than appears from the catch credited to this state. Two large factories have been erected at the mouth of Cape Fear River, where 50,917,800 fish were handled in 1902, but none of these fish has been included in the North Carolina catch, since they were taken by steamers owned in New York State. The catch by North Carolina vessels, however, increased from 11,310,000 pounds in 1897 to 18,862,000 pounds in 1902, representing 28 per cent of the total fishery product of the state for that year.

The yield of alewives has decreased from 15,790,437 pounds in 1897 to 11,172,975 pounds in 1902; of blue-fish from 1,696,175 to 977,142 pounds, and of sturgeon from 404,125 to 144,705 pounds; but mullet increased from 3,409,585 pounds to 6,705,492 pounds, squeteague from 3,090,254 to 3,781,456 pounds, croakers from 1,279,019 to 1,928,635 pounds, striped bass from 845,123 to 1,175,400 pounds, white and yellow perch from 806,379 to 1,047,042 pounds, hickory shad from 230,975 to 684,896 pounds, black bass from 535,342 to 632,675 pounds, and eels from 96,700 to 507,111 pounds. The increase in value of these items has been very much greater owing to the enhanced price per pound.

The tables following show the number of persons employed, the number and value of vessels, boats, and fishing apparatus, the value of the shore and accessory property, the amount of cash capital, and the

quantity and value of the products of the fisheries of North Carolina in 1902:

Table of persons employed.

How engaged.	No.
On vessels fishing	1,100
On vessels transporting	433
In shore or boat fisheries	10,059
Shoresmen	3,163
Total	14,755

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	188	$130,997	Apparatus—shore fisheries—Continued:		
Tonnage	1,654		Pound nets and weirs	2,982	$228,610
Outfit		30,770	Fyke nets	181	925
Vessels transporting	199	179,384	Minor nets	1,184	2,450
Tonnage	2,290		Lines		143
Outfit		19,853	Pots	3,512	3,359
Boats	6,472	222,151	Dredges	131	1,005
Apparatus—vessel fisheries:			Tongs and rakes	3,251	7,343
Seines	32	11,270	Wheels and slides	37	775
Gill nets	62	2,735	Miscellaneous		184
Dredges	276	6,244	Shore and accessory property		579,475
Tongs and rakes	100	410	Cash capital		237,050
Apparatus—shore fisheries:					
Seines	933	74,188			
Gill nets	107,129	234,120	Total		1,973,441

Table of products.

Species.	Lbs.	Value.	Species.	Lbs.	Value.
Alewives, fresh	3,171,975	$32,548	Sea bass	57,250	$1,929
Alewives, salted	8,001,000	83,664	Shad	6,566,724	384,808
Angel-fish	16,800	269	Sheepshead	154,929	7,303
Black bass	632,675	58,013	Snapper	9,500	213
Blue-fish, fresh	904,942	32,200	Spanish mackerel	354,084	19,948
Blue-fish, salted	72,200	2,068	Spot, fresh	663,895	12,732
Bonito	3,206	32	Spot, salted	208,800	7,384
Butter-fish	83,218	1,357	Squeteague, fresh	3,579,306	149,996
Carp, German	46,509	2,116	Squeteague, salted	202,150	6,251
Cat-fish	404,600	11,971	Strawberry bass	2,000	60
Cero	45,380	455	Striped bass	1,175,400	113,631
Crevalle	13,900	164	Sturgeon	134,125	7,473
Croaker, fresh	1,908,635	37,620	Caviar	10,580	7,874
Croaker, salted	20,000	700	Sucker	169,350	4,899
Drum	211,309	3,079	Sun-fish	14,800	434
Eel	507,111	19,962	Tautog	2,650	53
Flounder	261,762	5,256	Other fish	42,515	1,189
Hickory shad	681,896	33,552	Crab, hard	[a]3,000	100
King-fish or whiting	120,480	3,395	Crab, soft	[b]200,441	14,553
Menhaden	18,862,000	31,420	Shrimp	84,160	2,700
Mullet, fresh	3,258,906	76,901	Terrapin	[c]30,780	11,042
Mullet, salted	3,446,586	110,742	Turtle	[d]11,800	588
Perch, white	941,050	62,666	Frog	[e]5,990	599
Perch, yellow	105,992	5,639	Oyster	[f]7,159,691	268,363
Pig-fish	191,670	6,677	Quahog	[g]1,175,176	86,662
Pike	30,850	1,487	Scallop	[h]13,020	980
Pin-fish	32,476	418	Refuse fish	1,548,900	2,451
Pompano	19,590	965			
Sailor's choice	4,000	110	Total	67,584,734	1,739,661

[a] Represents 9,000 in number.
[b] Represents 601,323 in number.
[c] Represents 15,390 in number.
[d] Represents 280 in number.
[e] Represents 11,980 in number.
[f] Represents 1,022,813 bushels.
[g] Represents 146,897 bushels.
[h] Represents 2,170 bushels.

STATISTICS OF THE FISHERIES BY COUNTIES.

The following tables show the extent of the fisheries of North Carolina by counties. Carteret and Dare counties easily lead in number of persons employed, in amount of capital invested, and in quantity and value of the products, the yield amounting to 50 per cent of the total weight and 40 per cent of the total value for the state. They also have the greatest variety, nearly every important fishery product of North Carolina occurring in these two counties.

In 1902 Carteret County produced the entire catch of menhaden credited to this state, 85 per cent of the crabs, 50 per cent of the Spanish mackerel, 38 per cent of the oysters, quahogs, and blue-fish, 22 per cent of the mullet, 15 per cent of the squeteague or sea trout, and a large percentage of many of the minor species. Dare County yielded 70 per cent of the sturgeon, 50 per cent of the striped bass, 30 per cent of the blue-fish, hickory shad, mullet, shad, and squeteague, and 9 per cent of the oysters.

The most noticeable change in the fisheries of Carteret County since 1897 is an increase in the catch of menhaden from 11,310,000 to 18,862,000 pounds, of mullet from 953,775 to 1,505,472 pounds, of oysters from 365,325 to 393,986 bushels, and of quahogs from 38,426 to 54,925 bushels. On the other hand, there has been a decrease in the catch of blue-fish from 596,835 to 350,728 pounds, of king-fish from 192,365 to 56,590 pounds, of pig-fish from 145,265 to 22,820 pounds, of sea bass from 113,950 to 31,900 pounds, of sheepshead from 116,555 to 57,162 pounds, of squeteague from 742,758 to 562,078 pounds, and of soft crabs from 2,937,600 to 512,673 in number.

In Dare County the catch decreased from 8,560,398 pounds in 1897 to 8,031,922 pounds in 1902; but in the same period the value increased from $290,225 to $422,882. The quantity of spots, squeteague, striped bass, croakers, oysters, and quahogs increased, but the quantity of alewives, blue-fish, and shad decreased.

Currituck ranks third among the counties as regards value of the yield. In 1902 it produced 83 per cent of the 632,675 pounds of black bass taken in the state and 43 per cent of the 941,050 pounds of white perch. The value of the yield of these two species exceeds that of all others in this county. The catch of black bass and white perch was somewhat greater than in 1897, but the product of shad decreased from 364,400 pounds to 168,050 pounds in 1902. The total catch in Currituck County was 1,780,482 pounds in 1897 and 1,803,551 pounds in 1902, but the value per pound in the former year was 3.31 cents and in the latter 7.22 cents.

Chowan County yielded nearly 30 per cent of the alewives, more than twice as much as any other county. It also produced 11 per cent

of the shad taken in North Carolina. The yield of these two species amounted to 75 per cent of the value of the catch in the entire county.

The catch in Onslow County was made up of $43,716 worth of mullet, $16,522 worth of squeteague, $17,788 worth of oysters, $11,475 worth of quahogs, and $5,085 worth of other species. There has been a very large decrease in the oyster yield in this county, and the planting of oysters in New River, which was so promising a few years ago, is now attracting little attention.

In Beaufort County the value of oysters was 37 per cent and shad 20 per cent of the total yield. The catch credited to this county in 1897 was only $31,565; in 1902 it was $78,930, an increase of 150 per cent.

In Craven County there was a decrease since 1897 of 96 per cent in sturgeon, 66 per cent in striped bass, 62 per cent in shad, 60 per cent in alewives, 56 per cent in white perch, 44 per cent in spots, and 31 per cent in squeteague, but an increase of 100 per cent in croakers. The product of this county in 1897 was 2,624,168 pounds, worth 2.62 cents per pound; in 1902 it was 1,706,240 pounds, worth 3.01 cents per pound.

New Hanover County shows a falling off in the value of the yield from $94,249 in 1897 to $75,370, the decrease in oysters alone being from $28,000 to $2,000. The yield of shad decreased from 236,781 pounds to 167,280 pounds, croakers from 84,025 to 24,350 pounds, squeteague from 148,550 to 104,650 pounds, sturgeon from 93,750 to 17,338 pounds, and shrimp from 144,000 to 61,560 pounds. Mullet increased from 282,410 to 1,025,390 pounds, and clams from 18,000 to 21,965 bushels.

The Brunswick County fisheries are devoted principally to mullet and quahogs, and in 1902 the yield was valued at $57,892, of which $26,871 represents the mullet catch and $24,065 the quahog catch. The output of salt mullet had increased 158 per cent since 1897—from 333,100 to 858,700 pounds.

In Bertie, Tyrrell, and Washington counties 52 per cent of the value of the catch consisted of shad, 22 per cent of alewives, and nearly 7 per cent of hickory shad. The yield in the remaining counties was largely shad, in which there was a decrease in quantity but an increase in value since 1897.

Table showing by counties the number of persons employed in the fisheries of North Carolina in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Beaufort	169	12	360	562	1,103
Bertie		12	276	160	448
Bladen			128		128
Brunswick		46	592	164	802
Camden			75	5	80
Carteret	456	158	1,122	459	2,195
Chowan		18	409	456	883
Columbus			7		7
Craven	26	8	312	59	405
Cumberland			148		148
Currituck	21	10	582	14	627
Dare	150	50	1,483	208	1,891
Duplin			54		54
Greene			120		120
Halifax			116		116
Hertford			92	60	152
Hyde	89	16	493	53	651
Lenoir			291		291
Martin			135	30	165
New Hanover		19	580	9	608
Onslow	12	4	919		935
Pamlico	63	12	193	22	290
Pasquotank	114	49	161	365	689
Pender			248		248
Perquimans		9	139	58	206
Pitt			187		187
Sampson			142		142
Tyrrell		10	347	354	711
Washington			178	125	303
Wayne			170		170
Total	1,100	433	10,059	3,163	14,755

Table showing by counties the vessels, boats, and apparatus employed in the fisheries of North Carolina in 1902.

Items.	Beaufort.		Bertie.		Bladen.		Brunswick.		Camden.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	32	$17,777								
Tonnage	207									
Outfit		3,235								
Vessels transporting	6	2,858	6	$6,150			20	$14,381		
Tonnage	58		43				225			
Outfit		435						1,435		
Boats	230	6,850	131	3,285	97	$394	258	2,644	41	$2,225
Apparatus—vessel fisheries:										
Dredges	64	1,182								
Apparatus—shore fisheries:										
Seines	38	5,550	5	13,650	2	90	22	2,160	1	40
Gill nets	1,230	1,102	60	60	74	632	50	900	4,050	6,075
Pound nets and weirs	192	18,450	157	14,375					35	1,750
Minor nets	6	18	118	445	24	60				
Lines		4						12		
Pots	300	360	16	10						
Dredges	16	160								
Tongs and rakes	16	64					435	558		
Wheels and slides			10	150						
Miscellaneous										19
Shore and accessory property		55,325		39,800		600		153,300		770
Cash capital		49,500						10,000		
Total		162,870		77,925		1,776		215,390		10,879

Table showing by counties the vessels, boats, and apparatus employed in the fisheries of North Carolina in 1902—Continued.

Items.	Carteret.		Chowan.		Columbus.		Craven.		Cumberland.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	77	$61,441					4	$3,496		
Tonnage	692						55			
Outfit		15,425						615		
Vessels transporting	78	56,865	8	$9,890			3	3,095		
Tonnage	667		110				80			
Outfit		6,205		535				95		
Boats	1,176	34,868	184	8,835	6	$36	166	7,245	151	$628
Apparatus—vessel fisheries:										
Seines	25	10,040								
Gill nets	53	2,335								
Dredges	72	1,252					8	158		
Tongs and rakes	90	356								
Apparatus—shore fisheries:										
Seines	273	6,480	3	8,500			58	4,010	4	280
Gill nets	4,417	18,517	1,063	3,790	6	42	4,962	6,796	117	687
Pound nets and weirs			707	56,555						
Minor nets	360	90							40	104
Lines								8		
Pots			226	191			200	150		
Tongs and rakes	1,209	2,691								
Miscellaneous		20								
Shore and accessory property		76,035		65,560		20		26,550		800
Cash capital		59,550						15,500		
Total		352,170		153,856		98		67,718		2,499

Items.	Currituck.		Dare.		Duplin.		Greene.		Halifax.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	3	$2,485	22	$15,625						
Tonnage	32		162							
Outfit		560		4,270						
Vessels transporting	5	2,785	25	19,605						
Tonnage	36		227							
Outfit		585		4,827						
Boats	293	12,975	897	76,255	17	$121	72	$259	58	$330
Apparatus—vessel fisheries:										
Seines			5	850						
Dredges	4	150	34	1,200						
Tongs and rakes	4	30								
Apparatus—shore fisheries:										
Seines	230	9,495	60	2,745	12	320	6	210		
Gill nets	3,443	7,746	62,717	130,714	5	30	93	128		
Pound nets and weirs	83	4,570	707	65,895						
Fyke nets	110	550								
Minor nets			15	8			37	93	56	196
Lines				35						
Pots	1,359	1,359	443	543						
Dredges			91	565						
Tongs and rakes			454	729						
Wheels and slides									2	250
Miscellaneous		35		24						
Shore and accessory property		3,895		20,525		400		1,200		50
Total		47,220		344,415		871		1,890		826

Table showing by counties the vessels, boats, and apparatus employed in the fisheries of North Carolina in 1902—Continued.

Items.	Hertford.		Hyde.		Lenoir.		Martin.		New Hanover.		Onslow.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			17	$9,646							2	$1,010
Tonnage			172								11	
Outfit				1,425								580
Vessels transporting			8	4,900					6	$10,605	2	1,325
Tonnage			108						103		21	
Outfit				375						870		35
Boats	34	$950	318	16,301	162	$880	73	$815	318	6,553	651	13,540
Apparatus—vessel fisheries:												
Seines											2	380
Gill nets											9	400
Dredges			34	622								
Tongs and rakes											4	16
Apparatus—shore fisheries:												
Seines	4	2,800	32	700	14	410	2	1,200	41	2,920	17	2,442
Gill nets	110	225	7,017	10,896	20	60			428	8,276	666	9,740
Pound nets and weirs	11	275	74	7,145								
Fyke nets	10	40					4	20	10	80		
Minor nets			30	15	146	438	83	323	25	25		
Lines								25		52		5
Pots							10	10				
Dredges			24	280								
Tongs and rakes			328	1,213					230	300	255	1,051
Wheels and slides							25	375				
Miscellaneous				5								
Shore and accessory property		6,980		18,750		2,650		4,350		18,300		8,000
Cash capital				10,000						13,000		
Total		11,270		82,273		4,438		7,118		60,981		38,524

Items.	Pamlico.		Pasquotank.		Pender.		Perquimans.		Pitt.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	14	$6,082	17	$13,435						
Tonnage	126		197							
Outfit		1,285		3,375						
Vessels transporting	6	3,545	18	32,375			3	$7,575		
Tonnage	51		464				48			
Outfit		325		2,441				1,000		
Boats	215	6,030	92	2,705	215	$2,010	80	2,020	94	$345
Apparatus—vessel fisheries:										
Dredges	26	425	34	1,255						
Tongs and rakes	2	8								
Apparatus—shore fisheries:										
Seines	29	1,255	18	1,700	20	1,580	3	330	9	725
Gill nets	1,065	3,556	2,845	4,305	34	307	808	1,368		
Pound nets and weirs	184	15,860	58	2,960			163	9,175		
Fyke nets			27	135			10	50		
Minor nets					6	15	18	70	85	212
Pots	600	480	84	84			180	90		
Tongs and rakes	144	482			180	255				
Miscellaneous				81						
Shore and accessory property		12,850		20,655		1,610		3,970		2,000
Cash capital		1,500		48,000						
Total		53,683		133,506		5,777		25,648		3,282

Table showing by counties the vessels, boats, and apparatus employed in the fisheries of North Carolina in 1902—Continued.

Items.	Sampson.		Tyrrell.		Washington.		Wayne.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing									188	$130,997
Tonnage									1,654	
Outfit										30,770
Vessels transporting			5	$3,430					199	179,384
Tonnage			46						2,290	
Outfit				690						19,853
Boats	79	$422	174	9,515	74	$2,665	90	$450	6,472	222,151
Apparatus—vessel fisheries:										
Seines									32	11,270
Gill nets									62	2,735
Dredges									276	6,244
Tongs and rakes									100	410
Apparatus—shore fisheries:										
Seines	26	596			4	4,000			933	74,188
Gill nets	20	160	11,455	17,183	369	825			107,129	234,120
Pound nets and weirs			426	17,890	185	13,710			2,982	228,610
Fyke nets	10	50							181	925
Minor nets	42	105					93	233	1,184	2,450
Lines		2								143
Pots			94	82					3,512	3,359
Dredges									131	1,005
Tongs and rakes									3,251	7,343
Wheels and slides									37	775
Miscellaneous										181
Shore and accessory property		1,250		5,785		27,295		200		579,475
Cash capital										237,050
Total		2,585		54,575		48,495		883		1,973,441

Table showing by counties and species the yield of the fisheries of North Carolina in 1902.

Species.	Beaufort.		Bertie.		Bladen.		Brunswick.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	561,620	$5,553	193,500	$1,618	3,000	$90		
Alewives, salted			1,715,500	17,805				
Black bass	24,050	1,900			100	6		
Blue-fish, fresh	47,500	780					5,815	$290
Butter-fish	20,450	296						
Carp, German							360	8
Cat-fish	37,200	531	10,900	481				
Croaker, fresh	297,940	4,228					7,100	152
Drum							13,320	399
Eel	128,400	3,130	7,385	369				
Flounders	64,300	1,478					3,050	91
Hickory shad			83,000	3,962			120	6
Mullet, fresh	57,340	1,084					37,000	1,110
Mullet, salted							858,700	25,761
Perch, white	61,010	1,804	22,490	1,635	1,600	80		
Pig-fish							6,000	240
Pike	13,500	645						
Pompano	6,400	320						
Sea bass							9,400	472
Shad	223,220	15,904	472,590	23,972	29,320	2,199	20,920	1,569
Sheepshead	24,000	1,060					600	24
Spanish mackerel	10,350	518						
Spots, fresh	32,500	550					6,500	210
Squeteague, fresh	434,210	6,615					33,500	1,520
Striped bass	28,410	1,937	40,250	4,025			6,400	390
Sturgeon			200	40				
Suckers	23,000	490	15,500	627	2,000	40		
Sun-fish	6,250	160						
Terrapin	1,000	400					4,800	1,060
Turtle							4,000	240
Oyster	678,230	29,547					6,650	285
Quahog							329,920	24,065
Refuse fish			482,700	774				
Total	2,780,910	78,930	3,044,015	55,308	36,020	2,415	1,354,155	57,892

Table showing by counties and species the yield of the fisheries of North Carolina in 1902—Continued.

Species.	Camden.		Carteret.		Chowan.		Columbus.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	15,000	$180	24,500	$372	781,000	$6,248		
Alewives, salted	10,000	140			3,169,000	31,690		
Black bass					875	88		
Blue-fish, fresh			345,228	7,206				
Blue-fish, salted			5,500	165				
Bonito			2,806	28				
Butter-fish			17,868	277				
Carp, German					1,190	47		
Cat-fish	7,700	109			23,200	928		
Cero			43,280	434				
Crevalle			3,900	14				
Croaker, fresh			240,750	2,191				
Drum			102,494	849				
Eel	1,200	60			36,972	1,850		
Flounders			45,152	883	80	3		
Hickory shad	4,050	203			160,870	8,044		
King-fish or whiting			56,590	1,132				
Menhaden			18,862,000	31,420				
Mullet, fresh	7,200	120	946,266	19,275				
Mullet, salted			559,206	18,697				
Perch, white	11,900	714			53,925	4,314		
Perch, yellow	5,200	248			1,600	96		
Pig-fish			22,820	457				
Pike	900	90						
Pin-fish			4,826	39				
Pompano			8,640	432				
Porgy			700	16				
Sea bass			31,900	840				
Shad	158,400	7,670	80	7	725,920	37,096	1,920	$141
Sheepshead			57,162	2,331				
Spanish mackerel			177,089	10,511				
Spot, fresh			130,370	1,802				
Spot, salted			19,500	516				
Squeteague, fresh			551,028	16,505				
Squeteague, salted			11,050	298				
Striped bass	4,150	415	5,166	423	74,570	7,441		
Sturgeon					6,337	359		
Caviar					588	403		
Suckers					9,150	366		
Tautog			2,650	53				
Other fish	500	10						
Crab, soft			170,891	12,698				
Terrapin			1,600	1,069				
Turtle	900	45						
Frogs	1,400	140						
Oyster			2,757,902	109,956				
Quahog			439,400	29,772				
Scallop			13,020	980				
Refuse fish					692,700	1,154		
Total	228,500	10,144	25,661,394	271,629	5,737,977	100,127	1,920	144

Table showing by counties and species the yield of the fisheries of North Carolina in 1902—Continued.

Species.	Craven.		Cumberland.		Currituck.		Dare.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	190,800	$3,024			57,300	$589	243,200	$2,917
Alewives, salted	2,000	60			21,000	111	749,000	9,891
Black bass	32,500	2,000			528,600	50,649	29,000	2,320
Blue-fish, fresh	44,250	1,275			3,939	361	231,570	17,289
Blue-fish, salted							42,100	1,263
Butter-fish	13,000	210					11,000	246
Carp, German	2,000	60			4,295	215		
Cat-fish	4,000	80			71,500	3,353	122,200	2,666
Croaker, fresh	481,500	7,390			22,575	760	401,600	17,467
Croaker, salted							20,000	700
Drum	7,000	105					53,645	1,073
Eel	9,600	384			98,900	5,366	58,200	1,710
Flounders	14,500	215			1,200	60	19,360	584
Hickory shad	3,500	80			34,629	1,391	167,167	9,295
King-fish or whiting	2,400	56			3,150	211	21,840	1,049
Mullet, fresh	111,000	2,020			19,700	691	195,800	9,068
Mullet, salted					26,000	1,080	352,300	15,200
Perch, white	52,200	1,696	2,650	$138	406,073	35,449	73,300	3,818
Perch, yellow					71,582	4,095	14,510	652
Pig-fish	12,000	180			1,900	76	25,350	943
Pike	9,000	240			1,800	162	600	60
Pin-fish	10,000	100					4,250	85
Pompano							550	33
Porgy	10,000	150					2,000	40
Shad	209,520	15,369	40,080	3,171	168,050	8,635	2,014,420	126,385
Sheepshead	7,000	350			1,400	112	40,947	2,401
Spanish mackerel	1,600	128			1,250	125	69,900	3,834
Spot, fresh	56,000	850			25,000	650	257,150	5,136
Spot, salted					7,500	278	178,300	6,433
Squeteague, fresh	248,880	9,601			42,628	3,124	1,004,000	73,753
Squeteague, salted					12,100	360	148,500	4,593
Strawberry bass	2,000	60						
Striped bass	34,170	1,998			69,060	8,728	587,075	58,436
Sturgeon	2,260	140			8,510	510	98,050	5,702
Caviar	520	408			770	578	8,190	6,153
Suckers	30,000	460	3,500	105	11,725	366	9,800	294
Sun-fish							8,550	274
Other fish					39,015	1,112	1,800	27
Crab, soft							2,400	90
Terrapin							7,472	4,140
Turtle					1,100	55		
Oyster	103,040	4,540			41,300	1,146	690,970	22,347
Quahog							65,856	4,515
Total	1,706,240	53,229	46,230	3,414	1,803,551	130,398	8,031,922	422,882

Species.	Duplin.		Greene.		Halifax.		Hertford.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	1,625	$24	5,200	$104			287,500	$2,325
Alewives, salted							63,500	635
Black bass	600	36						
Carp, German					2,500	$125	424	17
Cat-fish	900	23	500	15	100	7	3,050	132
Flounders					1,200	24		
Hickory shad	400	16			100	2	2,060	103
Perch, white	4,520	186			10	1	7,875	630
Perch, yellow							200	12
Pike					75	12		
Shad	16,280	1,080	18,428	1,369	13,400	1,265	53,100	2,835
Striped bass	1,600	96			30,222	2,720	2,125	213
Sturgeon					1,430	130		
Suckers	5,650	113	2,500	50	125	10	8,400	346
Terrapin					433	260		
Refuse fish							3,000	5
Total	31,575	1,574	26,628	1,538	49,595	4,556	431,234	7,253

Table showing by counties and species the yield of the fisheries of North Carolina in 1902—Continued.

Species.	Hyde.		Lenoir.		Martin.		New Hanover.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	34,500	$452	900	$14	25,000	$205		
Alewives, salted					170,000	1,730		
Black bass							1,500	$150
Blue-fish, fresh	65,480	1,306					27,850	872
Blue-fish, salted	24,600	640						
Butter-fish	4,500	80						
Carp, German					6,000	300	3,700	74
Cat-fish			1,800	36	9,400	441	44,000	1,030
Crevalle	10,000	150						
Croaker, fresh	202,600	2,554					24,350	547
Drum	8,300	144					6,000	138
Eels					2,000	100		
Flounders	43,900	659					2,660	58
Hickory shad			1,200	36	22,800	912	640	32
King-fish, or whiting	6,000	180					8,050	242
Mullet, fresh	99,200	1,862					905,270	24,769
Mullet, salted	154,740	5,054					120,120	4,025
Perch, white			2,200	88	6,800	408	72,030	2,271
Pig-fish	23,000	460					82,500	3,930
Pike							700	50
Pin-fish							11,000	170
Sailor's choice							4,000	110
Sea bass							14,600	580
Shad	184,440	14,588	55,124	4,134	102,637	5,525	167,280	12,546
Sheepshead	2,520	126					2,000	80
Snappers							9,500	213
Spanish mackerel	47,280	2,364						
Spots, fresh	60,400	916					42,765	1,103
Squeteague, fresh	321,320	6,539					104,650	3,439
Squeteague, salted	18,000	380						
Striped bass	10,000	600	3,960	282	19,800	1,980	7,300	664
Sturgeon							17,338	592
Caviar							512	332
Suckers			200	2	6,750	270	500	10
Crab, hard							3,000	100
Crab, soft	7,150	515					20,000	1,250
Shrimp							61,560	2,120
Terrapin							1,500	450
Turtle							2,500	83
Oyster	1,108,345	45,186					56,000	2,000
Quahog	30,000	2,085					175,720	11,340
Refuse fish					31,500	26		
Total	2,466,275	86,840	65,384	4,592	402,687	11,897	2,001,095	75,370

Species.	Onslow.		Pamlico.		Pasquotank.		Pender.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	19,400	$228	93,350	$1,100	127,000	$1,530	4,500	$54
Alewives, salted					65,000	840		
Black bass					12,750	628	300	24
Blue-fish, fresh	33,650	769	98,800	2,026			860	26
Bonito	400	4						
Butter-fish			16,400	248				
Cat-fish					28,500	875	500	15
Cero	2,100	21						
Croaker, fresh	11,200	172	217,670	2,131			1,350	28
Drum	12,150	161					8,400	210
Eels			51,360	2,240	4,100	199		
Flounders	3,150	83	60,285	1,018	415	21	1,600	38
Hickory shad					260	14	300	12
King-fish, or whiting	4,050	81	18,400	444				
Mullet, fresh	525,920	10,363	282,700	4,596	15,300	255	55,410	1,656
Mullet, salted	1,138,500	33,353	99,720	2,903			137,300	4,669
Perch, white			12,800	378	25,300	1,180	4,600	210
Perch, yellow					9,000	340		
Pig-fish	10,500	214	4,100	72			3,500	105
Pike			2,500	50	475	48		
Pin-fish	200	2	2,200	22				
Pompano	200	10	3,800	190				
Porgy			4,100	63				
Sea bass	1,350	37						
Shad	2,800	175	46,769	3,450	88,400	4,470	26,280	1,673
Sheepshead	2,300	87	14,600	660			2,400	72
Spanish mackerel	9,850	549	36,765	1,919				
Spot, fresh	6,900	142	41,810	1,237			4,500	136
Spot, salted							3,500	157

Table showing by counties and species the yield of the fisheries of North Carolina in 1902—Continued.

Species.	Onslow.		Pamlico.		Pasquotank.		Pender.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Squeteague, fresh	348,590	$15,902	479,800	$12,582			10,700	$416
Squeteague, salted	12,500	620						
Striped bass	21,350	1,250	11,250	547	2,350	$235	1,300	73
Suckers					4,350	134	2,000	60
Other fish					1,200	40		
Shrimp							22,600	580
Terrapin	3,500	1,100	480	265	2,935	147	7,000	2,160
Turtle					3,300	165		
Frogs					4,590	459		
Oyster	836,570	17,788	505,610	22,794	263,074	7,964	112,000	4,800
Quahog	84,480	11,475					49,800	3,410
Total	3,091,610	94,586	2,105,269	60,935	658,299	19,544	460,700	20,584

Species.	Perquimans.		Pitt.		Sampson.		Tyrrell.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	235,500	$3,535	16,340	$312	9,240	$138	34,000	$272
Alewives, salted	142,000	2,272					785,000	7,950
Black bass					1,400	112		
Carp, German	1,200	37					380	15
Cat-fish	12,900	272	950	16	6,700	201	9,600	384
Eel	93,244	3,730					15,150	794
Flounders	460	23						
Hickory shad	27,900	1,395					54,300	2,715
Mullet, fresh	800	32						
Perch, white	32,417	1,944	1,200	36	14,100	678	38,350	2,572
Perch, yellow	1,900	76						
Pike	1,300	130						
Shad	276,400	13,870	44,700	2,970	50,176	2,943	832,000	41,600
Striped bass	15,672	1,567	350	27			88,120	8,512
Suckers	17,100	530			7,700	250	1,200	48
Refuse fish							76,500	154
Total	858,793	29,413	63,540	3,361	89,316	4,322	1,934,600	65,016

Species.	Washington.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	208,000	$1,664			3,171,975	$32,548
Alewives, salted	1,109,000	10,540			8,001,000	83,664
Black bass	1,000	100			632,675	58,013
Blue-fish, fresh					904,942	32,200
Blue-fish, salted					72,200	2,068
Bonito					3,206	32
Butter-fish					83,218	1,357
Carp, German	24,460	1,218			46,509	2,116
Cat-fish	9,000	376			404,600	11,971
Cero					45,380	455
Crevalle					13,900	164
Croaker, fresh					1,908,635	37,620
Croaker, salted					20,000	700
Drum					211,309	3,079
Eel	600	30			507,111	19,962
Flounders	450	18			261,762	5,256
Hickory shad	121,600	5,334			684,896	33,552
Kingfish, or whiting					120,480	3,395
Menhaden					18,862,000	31,420
Mullet, fresh					3,258,906	76,901
Mullet, salted					3,446,586	110,742
Perch, white	33,700	2,436			941,050	62,666
Perch, yellow	2,000	120			105,992	5,639
Pig-fish					191,670	6,677
Pike					30,850	1,487
Pin-fish					32,476	418
Pompano					19,590	965
Porgy					16,800	269
Sailor's choice					4,000	110
Sea bass					57,250	1,929
Shad	507,350	26,940	16,720	$1,254	6,566,724	384,808
Sheepshead					154,929	7,303
Snappers					9,500	213
Spanish mackerel					351,084	19,948

Table showing by counties and species the yield of the fisheries of North Carolina in 1902—Continued.

Species.	Washington.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Spot, fresh					663,895	$12,732
Spot, salted					208,800	7,384
Squeteague, fresh					3,579,306	149,996
Squeteague, salted					202,150	6,251
Strawberry bass					2,000	60
Striped bass	110,720	$11,072			1,175,400	113,631
Sturgeon					134,125	7,473
Caviar					10,580	7,874
Suckers	8,200	328			169,350	4,899
Sun-fish					14,800	434
Tautog					2,650	53
Other fish					42,515	1,189
Crab, hard					3,000	100
Crab, soft					200,441	14,553
Shrimp					84,160	2,700
Terrapin					30,780	11,042
Turtle					11,800	588
Frogs					5,990	599
Oyster					7,159,691	268,363
Quahog					1,175,176	86,662
Scallop					13,020	980
Refuse fish	262,500	338			1,548,900	2,451
Total	2,398,580	60,514	16,720	$1,254	67,584,734	1,739,661

THE YIELD BY DIFFERENT FORMS OF APPARATUS.

The product of the various forms of fishery apparatus used in North Carolina waters in 1902 is given in detail in the following series of tables. As regards value of the product, the gill net is the most important form of apparatus, the catch in 1902 being valued at $481,284, of which $218,860 represented shad, $81,206 mullet, $65,253 squeteague, $24,514 blue-fish, and the remaining $91,451 represented numerous other species. The use of gill nets has increased in this state in the last fifteen years. The value of those used in 1890 was $154,582, in 1897 it was $179,190, and in 1902 it amounted to $236,855. The value of the catch has increased correspondingly, amounting to $252,249 in 1890, $382,034 in 1897, and $481,284 in 1902.

The seine ranks second among the forms of apparatus as regards the value of the catch, this amounting to $454,594 in 1902, but it ranks first with respect to the quantity, yielding 32,339,889 pounds, or 48 per cent of the total product in the state. This is a large increase over 1897, when the seine catch amounted to 26,230,347 pounds, for which the fishermen received $340,055. The principal species caught by seines in 1902 were mullet, $105,197; shad, $59,605; black bass, $55,995; white perch, $42,516; alewives, $35,573; and menhaden, $31,420.

The use of pound nets in North Carolina has greatly increased in the last twenty-five years. In 1880, 117 were reported; in 1890 the number was 950; in 1897 it was 1,852, and in 1902 it had risen to 2,982.

The principal items in this fishery in the year under consideration were shad, $93,185; alewives, $77,845; striped bass, $67,380, and squeteague, $54,954. The total catch was 14,446,672 pounds, valued at $371,874, and in 1897 it was 14,080,660 pounds, for which $238,798 was received. These nets are set principally in Dare, Chowan, Beaufort, Washington, Perquimans, Pamlico, Bertie, and Tyrrell counties.

Dredges, rakes, tongs, etc., yielded $356,005 worth of products in North Carolina in 1902, the returns from 1,022,813 bushels of oysters, 146,897 bushels of quahogs or hard clams, and 2,170 bushels of scallops. The principal counties in which these were taken are Carteret, Hyde, Beaufort, Onslow, Dare, Brunswick, and Pamlico.

The remaining forms of apparatus used in North Carolina, with the respective values of their product in 1902, were: Lines, $23,883; bow nets, dip nets, etc., $20,951; eelpots, $17,640; wheels and slides, $3,372, fyke nets, $2,783, and miscellaneous forms, $7,275.

Table showing, by counties and species, the yield of the seine fisheries of North Carolina in 1902.

Species.	Beaufort.		Bertie.		Bladen.		Brunswick.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	161,200	$1,724	139,000	$1,122	3,000	$90		
Alewives, salted			1,158,000	11,720				
Black bass	21,450	1,692			100	6		
Blue-fish	5,000	100					2,215	$110
Cat-fish	6,000	110	4,500	205				
Croaker	131,400	1,280					3,500	70
Drum							7,820	234
Eel	4,000	60	2,000	100				
Flounders	1,500	45					2,550	76
Hickory shad			51,600	2,424				
Mullet, fresh	800	24					22,000	660
Mullet, salted							796,300	23,889
Perch, white	29,150	784	15,800	1,146	1,600	80		
Pike	13,500	645						
Sea bass							200	12
Shad	93,600	6,984	268,990	13,792	840	63		
Sheepshead	10,000	500					600	24
Spots, fresh	16,000	240					5,000	150
Squeteague, fresh	104,600	1,520					15,500	620
Striped bass	6,500	455	25,400	2,540			2,000	100
Suckers	17,000	340	7,900	323	2,000	40		
Sun-fish	6,250	160						
Sturgeon			200	40				
Terrapin							1,200	260
Turtle							4,000	240
Refuse fish			342,000	539				
Total	627,950	16,663	2,015,390	33,951	7,540	279	862,885	26,445

Table showing, by counties and species, the yield of the seine fisheries of North Carolina in 1902—Continued.

Species.	Camden.		Carteret.		Chowan.		Craven.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish			6,200	$140				
Butter-fish			850	14				
Croakers			17,260	166				
Drum			13,000	104				
King-fish			2,500	50				
Menhaden			17,676,000	29,460				
Mullet, fresh			432,544	8,760				
Mullet, salted			58,782	1,885				
Sea bass			1,800	50				
Sheepshead			3,376	127				
Spanish mackerel			6,800	401				
Spots			12,100	123				
Squeteague			119,156	4,376				
Total			18,350,368	45,656				
Shore fisheries:								
Alewives, fresh					125,000	$1,000	190,800	$3,024
Alewives, salted					502,500	5,025	2,000	60
Black bass							11,500	680
Blue-fish			52,150	1,120			44,250	1,275
Butter-fish			12,800	186			13,000	210
Cat-fish	1,700	$85					4,000	80
Carp, German							2,000	60
Croaker			67,200	516			224,000	2,970
Drum			12,300	126			7,000	105
Eel					2,250	113		
Flounders			3,000	69			14,500	215
Hickory shad					52,000	2,600	3,500	80
King-fish, or whiting			4,550	91			2,400	56
Menhaden			1,186,000	1,960				
Mullet, fresh			357,600	7,432			31,000	420
Mullet, salted			233,320	6,620				
Perch, white	4,400	264			7,500	600	34,700	1,046
Perch, yellow	1,200	48			200	12		
Pig-fish			3,600	72			12,000	180
Pike							9,000	240
Pin-fish							10,000	100
Pompano			3,700	165				
Porgy							10,000	150
Sea bass			15,870	421				
Shad					114,000	6,500	85,400	6,050
Sheepshead			14,650	394			7,000	350
Spanish mackerel			31,000	1,870			1,600	128
Spot, fresh			22,500	215			56,000	850
Spot, salted			4,000	84				
Squeteague, fresh			116,230	4,615			226,180	8,956
Squeteague, salted			6,850	172				
Strawberry bass							2,000	60
Striped bass			4,500	385	6,900	690	27,970	1,564
Suckers							30,000	460
Sturgeon					150	20		
Tautog			2,650	53				
Other fish	500	10						
Soft crab			138,017	10,264				
Terrapin			1,660	1,060				
Refuse fish					147,750	246		
Total	7,800	407	2,294,147	37,911	958,250	16,806	1,061,800	29,379
Total vessel and shore	7,800	407	20,644,515	83,567	958,250	16,806	1,061,800	29,379

Table showing, by counties and species, the yield of the seine fisheries of North Carolina in 1902—Continued.

Species.	Cumberland.		Currituck.		Dare.		Duplin.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Squeteague	....	....	....	....	4,767	$472	....	....
Striped bass	....	....	....	....	28,125	2,554	....	....
Total	....	....	....	....	32,892	3,026	....	....
Shore fisheries:								
Alewives, fresh	....	....	8,300	$161	....	....	1,625	$24
Black bass	....	....	527,500	50,539	29,000	2,320	600	36
Blue-fish	....	....	1,000	100	5,800	574	....	....
Cat-fish	....	....	49,300	2,265	7,500	225	900	23
Carp, German	....	....	3,255	163	....	....	....	....
Croaker	....	....	4,000	200	20,500	1,025	....	....
Eel	....	....	200	10	....	....	....	....
Flounders	....	....	....	....	4,700	188	....	....
Hickory shad	....	....	28,000	1,120	....	....	400	16
King-fish or whiting	....	....	1,800	108	2,190	110	....	....
Mullet, fresh	....	....	14,700	441	10,800	118	....	....
Mullet, salted	....	....	18,000	720	....	....	....	....
Perch, white	2,650	$138	384,023	33,589	4,900	254	4,520	186
Perch, yellow	....	....	68,742	3,925	....	....	....	....
Pike	....	....	1,800	162	600	60	....	....
Shad	9,720	894	....	....	....	....	14,680	980
Spanish mackerel	....	....	750	75	300	30	....	....
Spot, fresh	....	....	15,000	450	18,000	360	....	....
Squeteague, fresh	....	....	8,300	664	29,700	2,970	....	....
Striped bass	....	....	36,460	4,598	33,100	3,310	1,600	96
Suckers	3,500	105	8,635	270	....	....	5,650	113
Other fish	....	....	33,565	948	1,800	27	....	....
Total	15,870	1,137	1,213,330	100,508	168,890	11,571	29,975	1,474
Total vessel and shore	15,870	1,137	1,213,330	100,508	201,782	14,597	29,975	1,474

Species.	Greene.		Hertford.		Hyde.		Lenoir.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	5,200	$104	275,000	$2,200	....	....	900	$14
Alewives, salted	....	....	63,500	635	....	....	....	....
Blue-fish	....	....	....	....	9,650	$193	....	....
Cat-fish	500	15	1,900	76	....	....	1,800	36
Carp, German	....	....	424	17	....	....	....	....
Croaker	....	....	....	....	32,800	524	....	....
Drum	....	....	....	....	6,500	120	....	....
Flounders	....	....	....	....	20,000	280	....	....
Hickory shad	....	....	1,600	80	....	....	1,200	36
Mullet, fresh	....	....	....	....	18,000	360	....	....
Perch, white	....	....	5,850	468	....	....	2,200	88
Perch, yellow	....	....	200	12	....	....	....	....
Pig-fish	....	....	....	....	5,000	100	....	....
Shad	9,168	667	31,200	1,740	....	....	21,720	1,629
Spot, fresh	....	....	....	....	6,000	90	....	....
Squeteague, fresh	....	....	....	....	29,750	595	....	....
Striped bass	....	....	2,050	205	....	....	1,700	102
Suckers	2,500	50	6,000	250	....	....	....	....
Soft crab	....	....	....	....	5,720	429	....	....
Refuse fish	....	....	3,000	5	....	....	....	....
Total	17,368	836	390,724	5,688	133,420	2,691	29,520	1,905

Table showing, by counties and species, the yield of the seine fisheries of North Carolina in 1902—Continued.

Species.	Martin.		New Hanover.		Onslow.		Pamlico.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish					2,000	$15		
Croaker					2,600	24		
Drum					1,750	15		
King-fish					850	17		
Mullet, fresh					48,000	960		
Mullet, salted					6,450	194		
Sea bass					500	14		
Sheepshead					600	20		
Spanish mackerel					2,000	120		
Spot					2,000	20		
Squeteague					12,000	466		
Total					78,750	1,895		
Shore fisheries:								
Alewives, fresh	12,500	$100					17,200	$215
Alewives, salted	105,000	1,050						
Blue-fish			16,000	$480	800	$24	30,500	610
Butter-fish							9,600	128
Cat-fish	2,900	116						
Carp, German	6,000	300						
Croaker			14,350	287	2,250	56	78,420	761
Drum			5,400	120	4,000	80		
Flounders			2,410	48	600	12	7,635	153
Hickory shad	18,000	720						
King-fish or whiting			3,850	116			3,200	64
Mullet, fresh			504,380	13,587	38,950	779	43,800	816
Mullet, salted			115,120	3,850	947,300	27,606	18,720	510
Perch, white	5,300	318	27,100	813			12,800	378
Pig-fish					3,000	64	4,100	72
Pike							2,500	50
Pin-fish			8,000	110			2,200	22
Porgy							4,100	63
Shad	55,037	3,145					5,640	410
Sheepshead			2,000	80			5,200	240
Spanish mackerel							6,150	321
Spots, fresh			38,715	982			21,850	318
Squeteague, fresh			29,650	1,211	15,530	575	70,520	1,846
Striped bass	14,000	1,400	2,200	154	3,150	190	9,400	445
Suckers	1,000	40						
Shrimp			11,560	1,420				
Turtle			2,500	83				
Refuse fish	31,500	26						
Total	251,237	7,215	813,235	23,341	1,015,580	29,386	353,535	7,425
Total vessel and shore	251,237	7,215	813,235	23,341	1,094,330	31,281	353,535	7,425

Species.	Pasquotank.		Pender.		Perquimans.		Pitt.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	51,000	$656	4,500	$54	14,500	$218	16,340	$312
Alewives, salted	37,500	455			4,500	72		
Black bass	12,650	618	300	24				
Blue-fish			260	8				
Cat-fish	8,000	240	500	15	800	16	950	16
Carp, German					550	17		
Croaker			1,200	24				
Drum			8,400	210				
Eel					300	12		
Flounders			1,600	38				
Hickory shad			300	12	400	20		
Mullet, fresh			32,560	970	800	32		
Mullet, salted			134,300	4,564				
Perch, white	17,600	746	4,600	210	3,800	228	1,200	36
Perch, yellow	3,400	116						
Pig-fish			3,500	105				
Shad			15,240	940	3,000	200	19,860	1,418
Sheepshead			2,400	72				
Spot, fresh			4,200	126				
Spot, salted			3,500	157				
Squeteague, fresh			9,500	380				
Striped bass			1,300	73	322	32	350	27
Suckers	4,000	120	2,000	60	4,000	120		
Other fish	1,200	40						
Shrimp			22,600	580				
Terrapin	2,375	119						
Total	140,725	3,110	252,760	8,622	32,972	967	38,700	1,809

Table showing, by counties and species, the yield of the seine fisheries of North Carolina in 1902—Continued.

Species.	Sampson.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel, fisheries:						
Blue-fish					8,200	$185
Butter-fish					850	14
Croaker					19,860	190
Drum					14,750	119
King-fish					3,350	67
Menhaden					17,676,000	29,460
Mullet, fresh					480,544	9,720
Mullet, salted					65,232	2,079
Sea bass					2,300	64
Sheepshead					3,976	147
Spanish mackerel					8,800	521
Spot					14,100	143
Squeteague					135,923	5,314
Striped bass					28,125	2,554
Total					18,462,010	50,577
Shore fisheries:						
Alewives, fresh	9,240	$138	50,000	$400	1,088,305	11,556
Alewives, salted			500,000	5,000	2,373,000	24,017
Black bass	1,000	80			604,100	55,995
Blue-fish					167,625	4,594
Butter-fish					35,400	524
Cat-fish	2,200	66			93,450	3,589
Carp, German			24,000	1,200	36,229	1,757
Croakers					579,620	7,713
Drum					51,420	995
Eel					8,750	295
Flounders					58,495	1,115
Hickory shad			74,000	2,960	231,000	10,068
King-fish or whiting					17,990	545
Menhaden					1,186,000	1,960
Mullet, fresh					1,075,390	25,639
Mullet, salted					2,263,060	67,759
Perch, white	6,750	394	12,500	750	588,943	42,516
Perch, yellow					73,742	4,113
Pig-fish					31,200	593
Pike					27,400	1,157
Pin-fish					20,200	232
Pompano					3,700	165
Porgy					14,100	213
Sea bass					16,070	433
Shad	27,936	1,603	220,150	12,580	996,181	59,605
Sheepshead					41,850	1,660
Spanish mackerel					39,800	2,427
Spots, fresh					203,265	3,811
Spots, salted					7,500	241
Squeteague, fresh					655,460	23,952
Squeteague, salted					6,850	172
Strawberry bass					2,000	60
Striped bass			90,000	9,000	268,902	25,366
Suckers	4,500	140	2,000	80	100,685	2,511
Sun-fish					6,250	160
Sturgeon					550	60
Tautog					2,650	53
Other fish					37,065	1,025
Soft crab					143,737	10,693
Shrimp					64,160	2,000
Terrapin					5,235	1,439
Turtle					6,500	323
Refuse fish			120,000	100	644,250	916
Total	51,626	2,421	1,092,650	32,070	13,877,879	404,017
Total vessel and shore	51,626	2,421	1,092,650	32,070	32,339,889	454,594

Table showing, by counties and species, the yield of the gill-net fisheries of North Carolina in 1902.

Species.	Beaufort.		Bertie.		Bladen.		Brunswick.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives	4,000	$44						
Black bass	2,600	208						
Carp, German							360	$8
Cat-fish	13,200	196						
Croaker, fresh	10,860	826					2,600	52
Drum							5,500	165
Flounders	1,600	48					500	15
Hickory shad							120	6
Mullet, fresh	40,000	800					15,000	450
Mullet, salted							62,400	1,872
Perch, white	12,000	400						
Shad	26,120	1,814	4,000	$200	23,680	$1,776	20,920	1,569
Spots, fresh							1,500	60
Squeteague, fresh							3,500	175
Striped bass	3,100	186					4,400	290
Suckers	6,000	150						
Total	119,480	4,672	4,000	200	23,680	1,776	116,800	4,662

Species.	Camden.		Carteret.		Chowan.		Columbus.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish, fresh			117,928	$2,426				
Benito			2,806	28				
Butter-fish			1,468	22				
Cero			18,630	187				
Crevalle			500	2				
Croaker			29,970	299				
Drum			39,594	321				
Flounders			3,282	65				
King-fish or whiting			24,220	485				
Mullet, fresh			45,562	911				
Mullet, salted			51,704	1,836				
Pig-fish			2,700	54				
Pin-fish			1,076	9				
Pompano			2,099	105				
Porgy			80	2				
Sea bass			4,580	125				
Sheepshead			14,816	690				
Spanish mackerel			73,824	4,313				
Spots, fresh			13,400	249				
Squeteague, fresh			121,642	3,634				
Striped bass			96	4				
Total			572,968	15,767				
Shore fisheries:								
Alewives			21,500	372				
Blue-fish, fresh			168,950	3,520				
Blue-fish, salted			5,500	165				
Butter-fish			2,750	55				
Carp, German					335	$13		
Cero			24,650	247				
Crevalle			3,400	12				
Croaker, fresh			126,320	1,210				
Drum			37,609	298				
Flounders			6,270	134				
Hickory shad	4,050	$203			11,390	570		
King-fish or whiting			25,320	506				
Mullet, fresh	7,200	120	110,560	2,172				
Mullet, salted			212,460	8,356				
Pig-fish			16,520	331				
Pin-fish			3,750	39				
Pompano			2,850	142				
Porgy			620	14				
Sea bass			9,650	244				
Shad	134,400	6,720	80	7	172,320	8,616	1,920	$144
Sheepshead			24,320	1,120				
Spanish mackerel			65,465	3,927				
Spot, fresh			82,370	1,185				
Spot, salted			15,500	432				
Squeteague, fresh			194,000	3,880				
Squeteague, salted			4,200	126				
Striped bass	3,150	315	570	34	7,420	742		
Sturgeon					6,187	339		
Caviar					588	403		
Total	148,800	7,358	1,168,115	28,519	198,240	10,683	1,920	144
Grand total	148,800	7,358	1,741,083	44,286	198,240	10,683	1,920	144

Table showing, by counties and species, the yield of the gill-net fisheries of North Carolina in 1902—Continued.

Species.	Craven.		Cumberland.		Currituck.		Dare.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Black bass	3,000	$240						
Blue-fish, fresh					2,939	$261	178,900	$14,133
Blue-fish, salted							42,100	1,263
Croaker, fresh	40,000	600			18,575	560	184,350	8,079
Croaker, salted							20,000	700
Drum							48,645	973
Hickory shad							78,617	4,475
King-fish or whiting					1,350	103	12,150	596
Mullet, fresh	80,000	1,600			5,000	250	185,000	8,950
Mullet, salted					8,000	360	346,300	15,020
Perch, white	9,000	360						
Pig-fish					1,900	76	17,650	635
Shad	124,120	9,309	24,760	$1,857	146,050	7,535	1,597,900	100,155
Sheepshead					1,400	112	26,467	1,597
Spanish mackerel					500	50	6,800	661
Spot, fresh					10,000	200	211,600	4,225
Spot, salted					7,500	278	178,300	6,433
Squeteague, fresh	11,500	405			31,228	2,336	410,633	32,374
Squeteague, salted					12,100	360	144,800	4,334
Striped bass	6,200	434			2,600	260	32,550	3,242
Sturgeon	2,260	140			8,510	510	98,050	5,702
Caviar	520	408			770	578	8,190	6,153
Sun-fish							3,300	116
Terrapin							6,880	3,812
Total	276,600	13,496	24,760	1,857	258,422	13,829	3,869,182	223,631

Species.	Duplin.		Greene.		Hertford.		Hyde.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Blue-fish, fresh							37,650	$750
Blue-fish, salted							24,600	640
Croaker, fresh							5,000	50
Drum							1,800	24
King-fish or whiting							4,000	120
Mullet, fresh							81,200	1,502
Mullet, salted							154,740	5,054
Pig-fish							15,500	310
Shad	1,600	$100	4,940	$378	21,200	$1,060	162,560	12,958
Spanish mackerel							6,000	300
Spot, fresh							28,000	370
Squeteague, fresh							40,550	830
Squeteague, salted							18,000	380
Striped bass							2,500	150
Total	1,600	100	4,940	378	21,200	1,060	582,100	23,438

Species.	Lenoir.		New Hanover.		Onslow.		Pamlico.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish, fresh					14,000	$280		
Bonito					400	4		
Cero					2,100	21		
Croaker					2,550	26		
Drum					4,400	36		
Flounders					550	11		
King-fish or whiting					3,200	64		
Mullet, fresh					4,800	96		
Mullet, salted					6,850	223		
Pin-fish					200	2		
Pompano					200	10		
Sea bass					850	23		
Sheepshead					1,700	67		
Spanish mackerel					7,850	429		
Spot, fresh					1,200	12		
Squeteague, fresh					11,000	333		
Total					61,850	1,637		

Table showing, by counties and species, the yield of the gill-net fisheries of North Carolina in 1902—Continued.

Species.	Lenoir.		New Hanover.		Onslow.		Pamlico.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives					19,400	$228		
Blue-fish, fresh			8,350	$252	16,850	420	16,800	$386
Carp, German			3,700	71				
Croaker, fresh			2,000	60	3,800	66	42,750	418
Drum			600	18	2,000	30		
Flounders			250	10	2,000	60		
Hickory shad			640	32				
Mullet, fresh			400,890	11,182	434,170	8,528	210,500	3,260
Mullet, salted			5,000	175	177,900	5,330	71,300	2,113
Pig-fish					7,500	150		
Shad	4,480	$336	167,280	12,546	2,800	175	18,640	1,320
Spanish mackerel							5,250	315
Spot, fresh			4,050	121	3,700	110	4,500	64
Squeteague, fresh			23,200	708	293,560	13,846	32,830	876
Squeteague, salted					12,500	620		
Striped bass	160	12	4,600	460	18,200	1,060	1,850	102
Sturgeon			17,338	592				
Caviar			512	332				
Suckers			500	10				
Total	4,640	348	638,910	26,572	991,380	30,623	404,420	8,854
Grand total	4,640	348	638,910	26,572	1,056,230	32,260	404,420	8,854

Species.	Pasquotank.		Pender.		Perquimans.		Sampson.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives	8,000	$116						
Blue-fish, fresh			600	$18				
Croaker, fresh			150	4				
Hickory shad	110	6			3,300	$165		
Mullet, fresh	15,300	255	22,850	686				
Mullet, salted			3,000	105				
Shad	62,000	3,150	10,000	655	83,600	4,180	7,840	$440
Spot, fresh			300	10				
Squeteague, fresh			1,200	36				
Striped bass	1,250	125			4,200	420		
Total	86,660	3,652	38,100	1,514	91,100	4,765	7,840	440

Species.	Tyrrell.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Blue-fish, fresh					131,928	$2,706
Bonito					3,206	32
Butter-fish					1,468	22
Cero					20,730	208
Crevalle					500	2
Croaker					32,520	325
Drum					43,994	357
Flounders					3,832	76
King-fish or whiting					27,420	519
Mullet, fresh					50,362	1,007
Mullet, salted					61,554	2,059
Pig-fish					2,700	51
Pin-fish					1,276	11
Pompano					2,290	115
Porgy					80	2
Sea bass					5,430	148
Sheepshead					16,516	757
Spanish mackerel					81,674	4,742
Spot, fresh					14,600	261
Squeteague, fresh					132,642	3,967
Striped bass					96	4
Total					634,818	17,404

Table showing, by counties and species, the yield of the gill-net fisheries of North Carolina in 1902—Continued.

Species.	Tyrrell.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:						
Alewives					55,900	$760
Black bass					5,600	448
Blue-fish, fresh					431,039	19,740
Blue-fish, salted					72,200	2,068
Butter-fish					2,750	55
Carp, German	380	$15	200	$8	4,975	118
Cat-fish					13,200	196
Cero					24,650	247
Crevalle					3,400	12
Croakers, fresh					436,405	11,925
Croakers, salted					20,000	700
Drum					96,145	1,508
Flounders					10,620	267
Hickory shad	48,300	2,415	4,800	234	151,327	8,106
King-fish or whiting					42,820	1,325
Mullet, fresh					1,607,670	39,755
Mullet, salted					1,041,040	38,385
Perch, white					21,000	760
Pig-fish					59,070	1,502
Pin-fish					3,750	30
Pompano					2,850	142
Porgy					620	14
Sea bass					9,650	244
Shad	774,800	38,740	62,400	3,120	3,660,410	218,860
Sheepshead					52,187	2,829
Spanish mackerel					84,015	5,256
Spots, fresh					346,020	6,345
Spots, salted					201,300	7,143
Squeteague, fresh					1,072,201	55,466
Squeteague, salted					191,600	5,820
Striped bass	63,320	6,332	4,450	445	160,520	14,609
Sturgeon					132,345	7,283
Caviar					10,580	7,874
Suckers					6,500	160
Sun-fish					3,300	116
Terrapin					6,880	3,812
Total	886,800	47,502	71,850	3,807	10,044,539	463,880
Grand total	886,800	47,502	71,850	3,807	10,679,357	481,284

Table showing, by counties and species, the yield of the pound-net fisheries of North Carolina in 1902.

Species.	Beaufort.		Bertie.		Camden.		Chowan.		Currituck.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Shore fisheries;										
Alewives, fresh	396,420	$3,785	46,500	$432	15,000	$180	656,000	$5,248	49,000	$428
Alewives, salted			470,000	5,035	10,000	140	2,666,500	26,665	21,000	111
Black bass							875	88		
Blue-fish	42,500	680								
Butter-fish	20,450	296								
Carp, German							855	34	1,040	52
Cat-fish	18,000	225	6,400	276	6,000	24	23,200	928	12,700	613
Croaker	145,680	1,842								
Eels	6,000	110	1,185	59	1,200	60	6,422	322	600	30
Flounders	61,200	1,385					80	3	1,200	60
Hickory shad			28,200	1,410			97,480	4,874	6,384	261
Mullet, fresh	16,540	260								
Perch, white	19,860	620	4,990	387	7,500	450	46,425	3,714	17,150	1,419
Perch, yellow					4,000	200	1,400	84	2,540	152
Pike					900	90				
Pompano	6,400	320								
Shad	98,220	6,730	163,600	8,180	24,000	950	439,600	21,980	22,000	1,100
Sheepshead	14,000	560								
Spanish mackerel	10,350	518								
Spot	16,500	310								
Squeteague, fresh	328,610	5,060							3,100	124
Striped bass	18,840	1,296	12,850	1,285	1,000	100	60,250	6,009	30,000	3,870
Suckers			2,800	112			9,150	366	2,300	69
Other fish									4,400	132
Refuse fish			140,700	235			544,950	908		
Total	1,219,570	23,997	877,225	17,411	69,600	2,194	4,553,187	71,223	173,414	8,421

Table showing, by counties and species, the yield of the pound-net fisheries of North Carolina in 1902—Continued.

Species.	Dare.		Hertford.		Hyde.		Pamlico.		Pasquotank.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Shore fisheries:										
Alewives, fresh	243,200	$2,917	12,500	$125	34,500	$452	76,150	$885	65,000	$758
Alewives, salted	749,000	9,891							27,500	385
Black bass									100	10
Blue-fish	33,670	1,262			18,180	363	51,500	1,030		
Butter-fish	11,000	216			4,500	80	6,800	120		
Cat-fish	114,700	2,441	400	18					15,500	385
Crevalle					10,000	150				
Croaker	186,750	7,863			164,800	1,980	96,500	952		
Drum	5,000	100								
Eels	14,000	700							600	24
Flounders	14,660	396			23,900	379	52,650	865	415	21
Hickory shad	88,550	4,820	460	23					150	8
King-fish or whiting	7,500	343			2,000	60	15,200	380		
Mullet, fresh							28,400	520		
Mullet, salted	6,000	180					9,700	280		
Perch, white	68,400	3,564	825	66					4,900	294
Perch, yellow	14,510	652							3,900	156
Pig-fish	7,700	308			2,500	50				
Pike									475	48
Pin-fish	4,250	85								
Pompano	550	33					3,800	190		
Porgy	2,000	40								
Shad	416,520	26,230	700	35	21,880	1,630	22,489	1,720	26,400	1,320
Sheepshead	8,480	444			2,520	126	9,400	420		
Spanish mackerel	62,800	3,140			41,280	2,064	25,365	1,280		
Spots	27,550	551			26,400	456	15,460	855		
Squeteague, fresh	492,900	34,537			251,020	5,114	376,450	9,860		
Squeteague, salted	3,700	259								
Striped bass	493,300	49,330	75	8	7,500	450			1,100	110
Suckers	9,800	294	2,000	80					350	14
Sun-fish	5,250	158								
Terrapin									285	14
Total	3,091,740	150,784	16,960	355	610,980	13,354	789,864	19,357	146,675	3,547

Species.	Perquimans.		Tyrrell.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	212,000	$3,182	34,000	$272	158,000	$1,264	1,998,270	$19,928
Alewives, salted	137,500	2,200	785,000	7,950	609,000	5,540	5,475,500	57,917
Black bass					1,000	100	1,975	198
Blue-fish							145,850	3,335
Butter-fish							42,750	742
Carp, German	650	20			260	10	2,805	116
Cat-fish	7,600	166	9,600	384	9,000	376	223,100	5,836
Crevalle							10,000	150
Croaker							593,730	12,637
Drum							5,000	100
Eels	10,200	408	4,950	284	600	30	45,757	2,027
Flounders	460	23			450	18	155,015	3,150
Hickory shad	24,200	1,210	6,000	300	42,800	2,140	294,224	15,046
King-fish or whiting							24,700	783
Mullet, fresh							44,940	780
Mullet, salted							15,700	460
Perch, white	26,517	1,590	38,350	2,572	21,200	1,686	256,117	16,362
Perch, yellow	1,900	76			2,000	120	30,250	1,440
Pig-fish							10,200	358
Pike	1,300	130					2,675	268
Pin-fish							4,250	85
Pompano							10,750	543
Porgy							2,000	40
Shad	184,200	9,210	57,200	2,860	224,800	11,240	1,701,609	93,185
Sheepshead							34,400	1,550
Spanish mackerel							139,795	7,002
Spots							85,910	2,172
Squeteague, fresh							1,452,080	54,695
Squeteague, salted							3,700	259
Striped bass	11,150	1,115	24,800	2,180	16,270	1,627	677,135	67,380
Suckers	8,100	260	1,200	48	6,200	248	41,900	1,491
Sun-fish							5,250	158
Other fish							4,400	132
Terrapin							285	14
Refuse fish			76,500	154	142,500	238	904,650	1,535
Total	625,777	19,590	1,037,600	17,004	1,234,080	24,637	14,446,672	371,874

Table showing, by counties, the yield of the line fisheries of North Carolina in 1902.

Species.	Beaufort.		Brunswick.		Craven.		Dare.		Martin.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Black bass					18,000	$1,080				
Blue-fish			3,600	$180			13,200	$1,320		
Cat-fish									5,000	$250
Croaker	10,000	$280	1,000	30	217,500	3,820	10,000	500		
Perch, white					8,500	290				
Pig-fish			6,000	240						
Sea bass			9,200	460						
Sheepshead							6,000	360		
Squeteague	1,000	35	14,500	725	11,200	240	36,000	3,400		
Striped bass									3,800	380
Total	11,000	315	34,300	1,635	255,200	5,430	65,200	5,580	8,800	630

Species.	New Hanover.		Onslow.		Sampson.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Black bass	1,500	$150			400	$32	19,900	$1,262
Blue-fish	3,500	140					20,300	1,640
Cat-fish	36,000	830			2,400	72	43,400	1,152
Croakers	8,000	200					246,500	4,830
King-fish or whiting	4,200	126					4,200	126
Perch, white	44,930	1,458			3,500	140	56,930	1,888
Pig-fish	82,500	3,930					88,500	4,170
Pike	700	50					700	50
Pin-fish	3,000	60					3,000	60
Sailor's choice	4,000	110					4,000	110
Sea bass	14,600	580					23,800	1,040
Sheepshead							6,000	360
Snappers	9,500	213					9,500	213
Squeteague	51,800	1,520	16,500	$682			131,000	6,602
Striped bass							3,800	380
Total	264,230	9,367	16,500	682	6,300	241	661,530	23,833

Table showing, by counties, the catch by wheels and slides operated in North Carolina in 1902.

Species.	Bertie.		Halifax.		Martin.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh					2,500	$25	2,500	$25
Alewives, salted	25,000	$300			15,000	180	40,000	480
Carp, German			200	$10			200	10
Cat-fish			100	7			100	7
Hickory shad	1,400	56	100	2	1,000	40	2,500	98
Perch, white	1,700	102	10	1	1,500	90	3,210	193
Pike			75	12			75	12
Shad	12,000	600	1,000	25	16,000	800	29,000	1,425
Striped bass	2,000	200	2,222	200	2,000	200	6,222	600
Sturgeon			1,430	130			1,430	130
Suckers	4,800	192	125	10	4,750	190	9,675	392
Total	46,900	1,450	5,262	397	42,750	1,525	94,912	3,372

Table showing by counties the yield of the fyke-net fisheries of North Carolina in 1902.

Species.	Currituck.		Hertford.		Martin.		New Hanover.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	1,100	$110						
Cat-fish	9,500	475	750	$38	1,500	$75	8,000	$200
Hickory shad	245	10						
Perch, white	4,900	441	1,200	96				
Perch, yellow	300	18						
Suckers	790	27	400	16	1,000	40		
Striped bass							500	50
Other fish	1,050	32						
Total	17,885	1,113	2,350	150	2,500	115	8,500	250

Species.	Pasquotank.		Perquimans.		Sampson.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass							1,100	$110
Cat-fish	5,000	$250	4,500	$90	2,100	$63	31,350	1,191
Hickory shad							245	10
Perch, white	2,800	140	2,100	126	3,850	144	14,850	947
Perch, yellow	1,700	68					2,000	86
Suckers			5,000	150	3,200	110	10,390	343
Striped bass							500	50
Other fish							1,050	32
Terrapin	275	14					275	14
Total	9,775	472	11,600	366	9,150	317	61,760	2,783

Table showing by counties the catch of eels by pots in North Carolina in 1902.

Counties.	Lbs.	Value.	Counties.	Lbs.	Value.
Beaufort	118,400	$2,960	Pamlico	51,360	$2,240
Bertie	4,200	210	Pasquotank	3,500	175
Chowan	28,300	1,415	Perquimans	82,744	3,310
Craven	9,600	384	Tyrrell	10,200	510
Currituck	98,100	5,326			
Dare	44,200	1,010	Total	452,604	17,640
Martin	2,000	100			

Table showing by counties the catch by minor nets in North Carolina in 1902.

Species.	Beaufort.		Bertie.		Bladen.		Carteret.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh			8,000	$64				
Alewives, salted			62,500	750				
Hickory shad			1,800	72				
Shad	5,280	$376	21,000	1,200	4,800	$360		
Crab, soft							32,871	$2,434
Total	5,280	376	96,300	2,086	4,800	360	32,871	2,434

Species.	Cumberland.		Dare.		Greene.		Halifax.		Hyde.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Carp, German							2,300	$115		
Shad	5,600	$420			4,320	$324	12,400	1,240		
Striped bass							28,000	2,520		
Crab, soft			2,400	$90					1,430	$86
Total	5,600	420	2,400	90	4,320	324	42,700	3,875	1,430	86

Table showing by counties the catch by minor nets in North Carolina in 1902—Continued.

Species.	Lenoir.		Martin.		New Hanover.		Pender.		Perquimans.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh			10,000	$80					9,000	$135
Alewives, salted			50,000	500						
Hickory shad			3,800	152						
Shad	28,924	$2,169	31,600	1,580			1,040	$78	5,600	280
Striped bass	2,100	168								
Suckers	200	2								
Crab, hard					3,000	$100				
Crab, soft					20,000	1,250				
Shrimp					20,000	700				
Total	31,224	2,339	95,400	2,312	43,000	2,050	1,040	78	14,600	415

Species.	Pitt.		Sampson.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh							27,000	$279
Alewives, salted							112,500	1,250
Carp, German							2,300	115
Hickory shad							5,600	224
Shad	24,840	$1,552	14,400	$900	16,720	$1,254	179,524	11,733
Striped bass							30,100	2,688
Suckers							200	2
Crab, hard							3,000	100
Crab, soft							56,704	3,860
Shrimp							20,000	700
Total	24,840	1,552	14,400	900	16,720	1,254	436,928	20,951

Table showing by counties the catch by dredges, tongs, rakes, etc., in North Carolina in 1902.

Species.	Beaufort.		Brunswick.		Carteret.		Craven.		Currituck.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Oyster	592,340	$25,772			996,198	$44,572	103,040	$4,540	41,300	$1,146
Quahog					640	60				
Total	592,340	25,772			996,838	44,632	103,040	4,540	41,300	1,146
Shore fisheries:										
Oyster	85,890	3,775	6,650	$285	1,761,704	65,391				
Quahog			329,920	24,065	438,760	29,712				
Scallop					13,020	980				
Total	85,890	3,775	336,570	24,350	2,213,484	96,086				
Total vessel and shore	678,230	29,547	336,570	24,350	3,210,322	140,718	103,040	4,540	41,300	1,146

Species.	Dare.		Hyde.		New Hanover.		Onslow.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Oyster	311,150	$9,187	287,665	$12,556			23,100	$540
Total	311,150	9,187	287,665	12,556			23,100	540
Shore fisheries:								
Oyster	379,820	13,160	820,680	32,630	56,000	$2,000	813,470	17,248
Quahog	65,856	4,515	30,000	2,085	175,720	11,340	84,480	11,475
Total	445,676	17,675	850,680	34,715	231,720	13,340	897,950	28,723
Total vessel and shore	756,826	26,862	1,138,345	47,271	231,720	13,340	921,050	29,263

Table showing by counties the catch by dredges, tongs, rakes, etc., in North Carolina in 1902—Continued.

Species.	Pamlico.		Pasquotank.		Pender.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Oyster	199,290	$8,826	263,074	$7,964			2,817,157	$115,103
Quahog							640	60
Total	199,290	8,826	263,074	7,964			2,817,797	115,163
Shore fisheries:								
Oyster	306,320	13,968			112,000	$4,800	4,342,534	153,260
Quahog					49,800	3,410	1,174,536	86,602
Scallop							13,020	980
Total	306,320	13,968			161,800	8,210	5,530,090	240,842
Total vessel and shore	505,610	22,794	263,074	7,964	161,800	8,210	8,347,887	356,005

Table showing, by counties, the extent of the menhaden industry of North Carolina in 1902.

Items.	Brunswick.		Carteret.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Establishments	2	$150,000	7	$31,275	9	$181,275
Cash capital		40,000		21,500		61,500
Shore employees	164		93		257	
Fishermen and transporters			141		141	
Sail vessels fishing			11	13,981	11	13,981
Tonnage			115		115	
Outfit				4,830		4,830
Purse seines			11	7,475	11	7,475
Sail vessels transporting			10	9,332	10	9,332
Tonnage			112		112	
Outfit				580		580
Menhaden received	50,917,800		30,656,000		81,573,800	
Oil prepared ... gallons	60,500	15,153	108,229	24,761	168,500	39,914
Scrap prepared ... tons	5,358	79,892	2,155	51,364	7,513	131,256

Table showing the persons and capital in the wholesale trade in fishery products in North Carolina in 1902.

Counties.	Establishments.		Cash capital.	Number of employees.
	No.	Value.		
Beaufort	10	$28,875	$23,500	415
Carteret	11	16,950	17,550	69
Craven	6	19,350	15,500	59
New Hanover	4	11,650	13,000	9
Pamlico	3	5,650	1,500	22
Total	34	82,475	71,050	574

Table showing, by counties, the extent of the canning industries of North Carolina in 1902.

Items.	Beaufort.		Carteret.		Hyde.		Pasquotank.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	1	$20,000	3	$16,950	1	$15,000	2	$18,000	7	$69,950
Cash capital		26,000		17,500		10,000		45,000		98,500
Employees	152		297		53		332		834	
Clams received ... bushels			8,280	4,554	19,860	11,720			28,140	16,274
Oysters received ... do	92,600	30,615	270,620	53,350			140,000	44,400	503,220	128,365
Clams canned ... 1-lb cans			47,040	3,920	107,172	13,396			154,212	17,316
Do ... 2-lb cans			42,720	6,764	58,974	11,794			101,694	18,558
Clam juice ... gallons			2,400	1,152	600	300			3,000	1,452
Oysters canned ... 1-lb cans	512,740	31,538	977,280	58,991			772,600	46,613	2,262,620	137,145
Do ... 2-lb cans	241,073	28,743	654,960	76,342			335,000	37,474	1,231,033	142,559
Clam juice ... 1-lb cans					63,608	4,770			63,608	4,770
Do ... 2-lb cans					103,325	10,745			103,325	10,745

FISHERIES OF SOUTH CAROLINA.

The greater part of the coast of South Carolina consists of swampy land intersected with numerous creeks, rivers, and bays. In these waters the shore or boat fisheries are chiefly prosecuted, while the vessels resort for their catch principally to the offshore grounds.

The number of persons employed in the coast fisheries of this state in 1902 was 3,713, of whom 97 were vessel fishermen, 10 were on vessels transporting fishery products, 2,071 in the shore fisheries, and 1,535 were shoresmen in the wholesale fishery trade, oyster canneries, and other industries on shore connected with the fisheries. Compared with the returns for 1897, the year for which the last canvass was made, there has been an increase of 1,574 persons, or 73.58 per cent.

The amount of capital invested was $320,723. This included 25 fishing and transporting vessels, valued at $21,450, their net tonnage being 340 tons, and the value of their outfit $6,282; 1,106 boats, valued at $34,335; fishing apparatus used on vessels and boats to the value of $19,438; shore and accessory property worth $86,518; and $152,700 cash capital utilized in the various fishery industries. These data indicate an increase in the investment, since 1897, of $146,369, or 83.94 per cent.

The total yield of the fisheries in 1902 was 8,174,463 pounds, having a value to the fishermen of $263,023, which is an increase over 1897 of 2,894,017 pounds, or 54.80 per cent in quantity, and of $52,567, or 24.97 per cent, in value. Notwithstanding this, however, South Carolina is now last in importance among the South Atlantic States in both the quantity and value of its fishery products, having exchanged places with Georgia in this respect.

Shad fishery.—The catch of shad in the waters of South Carolina in 1902 was 434,133 pounds, valued at $20,782, a decrease, as compared with the yield for 1897, of 71,992 pounds and $6,914. There was an increase in certain localities, but this was not great enough to offset the decline in other parts of the state.

In the vicinity of Charleston the catch, taken for the most part in the Edisto River, was much larger in 1902 than in previous years. A small amount of fishing was done on the Ashepoo River between its mouth and the railroad station at Ashepoo, whence the fish were shipped to Charleston. The shad fisheries of the Combahee River are prosecuted between the mouth of the river and the railroad crossing at Salkehatchie station. Very little fishing is done above this point, and only in a desultory manner, the few shad caught being consumed locally.

Winyah Bay and its tributory streams constitute one of the principal shad-producing regions of South Carolina, and yield a large percentage of the entire catch of the state. The bay and Waccamaw River furnish the greater part of this, Santee River a small quantity. The

number of gill nets in use in these waters in 1902 was 140, having a length of 54,100 yards and a value of $8,490; 230 men were employed in the fisheries, using 140 boats, which were valued at $5,460. The catch amounted to 81,000 shad, having a weight of 344,133 pounds and a value of $15,207. The prices paid to the fishermen averaged about 25 cents for roes and 15 cents for bucks, the catch being three-eighths roes and five-eighths bucks. In recent years the shad fisheries in this section have declined materially, and the catch of 1902 shows a falling off of 133,867 pounds in quantity and $11,083 in value since 1897. During the shad season there is considerable rivalry among the dealers in the purchase of shad from the fishermen, some dealers supplying boats and nets free of cost in order to insure obtaining their catch of fish.

Sturgeon fishery.—The sturgeon fishery of South Carolina shows a great decline when compared with the statistics for 1897. The catch in 1902 aggregated 83,950 pounds, valued at $3,736, a decrease of 327,150 pounds and $3,589. The quantity of caviar made from sturgeon roe in 1902 was 10,200 pounds, valued at $5,410, a decrease of 59,605 pounds and $12,115. Many persons attribute the growing scarcity of sturgeon to the destruction of the young caught in the gill nets of the shad fishermen. Very few such fish are returned to the water alive, which negligence materially contributes to the extermination of this valuable species.

The apparatus used in the sturgeon fishery is gill nets. These average 900 feet in length, with a depth of about 22 feet, and have a mesh of 12 to 15 inches.

Oyster fishery.—In South Carolina the oyster fishery represents about 45 per cent of the entire value of the fisheries. The catch in 1902 was 689,700 bushels, valued at $118,460, an increase, as compared with 1897, of 474,800 bushels and $73,100. The greater part of the catch, or 609,500 bushels, valued at $103,450, was taken in the shore fisheries by 938 men, with 609 boats, valued at $21,430. In the vessel fisheries 80,200 bushels were secured, having a value of $15,010.

Terrapin fishery.—The catch of diamond-back terrapin in this state in 1902 was 27,521 pounds, valued at $5,850, a decrease as compared with the statistics for 1897, of 13,395 pounds and $3,785. This fishery employs 98 men, with 49 seines having a total length of 12,000 feet, and 34 boats, valued at $940. In addition to the men and boats in the seine fishery, 100 men and boys, using 50 boats, were engaged in what is locally termed "bogging." The "boggers" tramp through the bogs and marshes bordering the remote inland creeks, and the splashing noise thus made attracts the terrapin to the surface of the pools, when they may be readily caught by hand. They are sold to dealers who visit the fishermen weekly, and who keep them in "crawls" or pounds for fattening for the late fall or winter market.

Capt. Robert Magwood, of Mount Pleasant, S. C., buys annually large quantities of terrapin, which he keeps in confinement awaiting orders for shipment. His pond, or "crawl," is about three-fourths of an acre in extent and well equipped for the purpose. Within the pond sand pans have been constructed in which the female deposits her eggs and the young are hatched. The eggs laid in May and June usually hatch the latter part of August and in September. No attempt is made to rear the young in the pond, owing to their slow growth, and they are set at liberty as soon as they are able to crawl about. Captain Magwood estimates that he liberates each season from 300 to 500 young terrapin which have hatched in his pond while the adults are being held for market.

Sharks utilized for food.—Sharks are plentiful in the waters of this State, and, as noted in a former report, the use of their flesh for food still finds favor with the poorer class of the negro population. The flesh is firm and white, presents an inviting appearance, and is said to be very palatable. When placed on sale, the meat is cut up in strips, tied in bunches weighing about 2 pounds each, and sold for 10 cents a bunch. The sharks are caught on lines and weigh from 10 to 200 pounds each. Those offered for sale average about 35 pounds, the fishermen receiving 2 cents a pound from the dealers. The catch in 1902 was 90,000 pounds, valued at $1,800, an increase of 60,000 pounds over the sales reported in 1897.

Statistics.—The following tables show in condensed form the number of persons employed, the amount of capital invested, and the quantity and value of products secured in the fisheries of South Carolina in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	97
On vessels transporting	10
In shore or boat fisheries	2,071
Shoresmen	1,535
Total	3,713

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels, fishing	22	$16,150	Apparatus—shore fisheries:		
Tonnage	313		Seines	61	$2,320
Outfit		5,157	Gill nets	227	13,360
Vessels, transporting	3	5,300	Cast nets	130	650
Tonnage	27		Lines		1,055
Outfit		1,125	Tongs	90	618
Boats	1,106	34,335	Hoes	23	13
Apparatus—vessel fisheries:			Grabs	429	646
Gill nets	2	135	Shore and accessory property		86,518
Lines		522	Cash capital		152,700
Dredges	4	42			
Tongs	8	54	Total investment		320,723
Grabs	17	23			

Table of products.

Species.	Lbs.	Value.	Species.	Lbs.	Value.
Amber fish	5,000	$150	Shark	90,000	$1,800
Blue-fish	1,000	40	Sheepshead	26,650	1,082
Bastard snapper	25,000	640	Spot	21,800	484
Cat-fish	500	15	Squeteague	85,700	3,059
Channel bass	102,000	3,550	Striped bass	9,800	768
Croaker	27,000	640	Sturgeon	83,950	3,736
Drum	75,200	1,396	Caviar	10,200	5,410
Flounder	1,900	66	Whiting	606,300	30,118
Grouper	41,000	1,025	Crab, hard	96,200	995
Hickory shad	30,600	1,416	Shrimp	366,500	12,452
Jew-fish	79,500	3,738	Prawn	3,000	150
Mullet	138,600	3,782	Oyster	[a] 4,827,900	118,460
Pompano	5,000	500	Clam	[b] 225,064	12,940
Red snapper	10,100	303	Terrapin	27,521	5,850
Sailor's choice	7,800	312			
Sea bass	709,545	27,364	Total	8,174,463	263,023
Shad	434,133	20,782			

[a] 689,700 bushels. [b] 28,133 bushels.

STATISTICS OF THE FISHERIES BY COUNTIES.

The coast fisheries of South Carolina are prosecuted in Beaufort, Berkeley, Charleston, and Georgetown counties. In Charleston County, which has about 50 per cent of the industry, the number of persons employed in 1902 was 1,747, the investment $181,016, and the products 4,649,711 pounds, valued at $184,579. Next in importance is Beaufort County, where 1,605 persons were employed, $101,348 invested, and the products amounted to 2,740,605 pounds, valued at $44,382.

The extent of the fisheries in each county of South Carolina in 1902 is given in the following tables:

Table showing by counties the number of persons employed in the fisheries of South Carolina in 1902.

How engaged.	Beaufort.	Charleston.	Georgetown.	Berkeley.	Total.
On vessels fishing	21	74	2		97
On vessels transporting		8	2		10
Boat or shore fishermen	714	1,052	295	10	2,071
Shoresmen	870	613	52		1,535
Total	1,605	1,747	351	10	3,713

Table showing by counties the vessels, boats, and apparatus employed in the fisheries of South Carolina in 1902.

Items.	Beaufort.		Berkeley.		Charleston.		Georgetown.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	6	$1,350			15	$14,700	1	$100	22	$16,150
Tonnage	47				259		7		313	
Outfit		2,354				2,723		80		5,157
Vessels transporting					2	5,000	1	300	3	5,300
Tonnage					22		5		27	
Outfit						1,000		125		1,125
Boats	425	9,470	5	$250	467	17,590	209	7,025	1,106	34,335
Apparatus—vessel fisheries:										
Gill nets							2	135	2	135
Lines						522				522
Dredges					4	42			4	42
Tongs	2	12			4	28	2	14	8	54
Grabs	17	23							17	23
Apparatus—shore fisheries:										
Seines	20	670			38	1,350	3	300	61	2,320
Gill nets			5	375	59	2,950	163	10,035	227	13,360
Cast nets	30	150			100	500			130	650
Lines		55				990		10		1,055
Tongs					55	408	35	210	90	618
Hoes					23	13			23	13
Grabs	429	646							429	646
Shore and accessory property		22,118		100		57,200		7,100		86,518
Cash capital		64,500				76,000		12,200		152,700
Total		101,348		725		181,016		37,634		320,723

Table showing by counties and species the yield of the fisheries of South Carolina in 1902.

Species.	Beaufort.		Berkeley.		Charleston.		Georgetown.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish					5,000	$150			5,000	$150
Bastard snapper					25,000	640			25,000	640
Blue-fish	1,000	$40							1,000	40
Cat-fish							500	$15	500	15
Channel bass	4,000	120			98,000	3,430			102,000	3,550
Croaker	3,000	120			22,000	440	2,000	80	27,000	640
Drum	43,500	435			30,000	900	1,700	61	75,200	1,396
Flounders							1,900	66	1,900	66
Groupers					41,000	1,025			41,000	1,025
Hickory shad					3,800	76	26,800	1,340	30,600	1,416
Jew-fish					79,500	3,738			79,500	3,738
Mullet	11,000	380			32,000	1,280	95,600	2,122	138,600	3,782
Pompano					5,000	500			5,000	500
Red snapper					10,100	303			10,100	303
Sailor's choice					7,800	312			7,800	312
Sea bass	3,500	145			704,045	27,119	2,000	100	709,545	27,364
Shad					90,000	5,575	344,133	15,207	434,133	20,782
Sharks					90,000	1,800			90,000	1,800
Sheepshead	650	32			25,000	1,000	1,000	50	26,650	1,082
Spot					20,800	444	1,000	40	21,800	484
Squeteague					81,000	2,800	4,700	259	85,700	3,059
Striped bass					9,000	720	800	48	9,800	768
Sturgeon			12,000	$840	40,000	1,600	31,950	1,296	83,950	3,736
Whiting	21,000	830			580,000	29,000	5,300	288	606,300	30,118
Crab	1,200	45			95,000	950			96,200	995
Shrimp	8,500	340			358,000	12,112			366,500	12,452
Terrapin	3,355	750			24,166	5,100			27,521	5,850
Oyster	2,636,900	40,995			2,089,500	74,265	101,500	3,200	a4,827,900	118,460
Prawn	3,000	150							3,000	150
Clam					80,000	7,500	145,064	5,440	b225,061	12,940
Caviar			600	270	4,000	1,800	5,600	3,310	10,200	5,410
Total	2,740,605	44,382	12,600	1,110	4,649,711	184,579	771,547	32,952	8,174,463	263,023

a 689,700 bushels.

b 28,133 bushels.

THE PRODUCTS BY APPARATUS.

Vessel fisheries.—The vessel fisheries of South Carolina in 1897 were confined to Charleston County, but in 1902 they were prosecuted in Beaufort, Charleston, and Georgetown Counties. The number of vessels also, including those engaged in transporting fishery products, increased from 16 to 25. The transporting vessels decreased from 4 to 3, but the fishing vessels increased from 12 to 22 in number.

The apparatus used in the vessel fisheries consisted of gill nets, lines, tongs, dredges, and grabs, and the yield aggregated 926,900 pounds, valued at $29,492—an increase over 1897 of 683,900 pounds in quantity and $18,326 in value.

Oysters are the most valuable product of the vessel fisheries, the catch being 80,200 bushels, or 561,400 pounds, exclusive of shells, valued at $15,010. This catch was made chiefly with tongs, dredges, and grabs, but a considerable quantity was picked by hand from the reefs at low tide.

The products secured with lines in the vessel fisheries in 1902 amounted to 354,300 pounds, valued at $13,944—an increase over 1897 of 132,900 pounds and $5,128. Sea bass was the most important species, the catch amounting to 263,700 pounds, valued at $11,588. Amber-fish, bastard snapper, grouper, jew-fish, and red snapper were also taken in smaller quantities.

Gill nets were not employed in the vessel fisheries except in Georgetown County, and the catch was of minor importance, being only 11,200 pounds, valued at $538.

Shore fisheries.—The various forms of apparatus used in the shore fisheries of South Carolina are seines, gill nets, lines, cast nets, tongs, hoes, and grabs. The total yield in 1902 amounted to 7,247,563 pounds, valued at $233,531.

The forms of apparatus yielding the largest returns were tongs, hoes, and grabs used in the oyster and clam fisheries. The catch of oysters with tongs and grabs, together with 280,000 bushels picked by hand on the natural beds at low tide and utilized for canning purposes, was 609,500 bushels, valued at $103,450. There were also taken with tongs and hoes 28,133 bushels of hard clams, valued at $12,940.

The catch with lines amounted to 1,560,995 pounds, valued at $58,953. The species taken in largest quantities were whiting, 603,000 pounds, $29,950, and sea bass, 443,845 pounds, $15,706. The whiting is known locally as "Carolina whiting" and "deep-water whiting," the latter name being applied probably because this species is seldom taken near the shore.

The gill-net catch was 546,283 pounds, with a value of $30,430. Among the more important species secured with this apparatus were shad, 414,133 pounds, $19,582; sturgeon, including caviar, 92,150 pounds, $8,956; and hickory shad, 29,800 pounds, $1,400.

Seines were used in Beaufort, Charleston, and Georgetown counties, the total catch aggregating 280,180 pounds, valued at $14,554. The most valuable species taken was terrapin, amounting to 21,480 pounds, with a value of $4,575. There were also 6,041 pounds of terrapin, valued at $1,275, taken by "boggers."

Cast nets are used principally in the shrimp fishery, the catch thus taken consisting of 356,500 pounds of shrimp, valued at $11,752, and 6,000 pounds of mullet, valued at $180.

The following tables give the products of the vessel and shore fisheries separately by forms of apparatus:

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of South Carolina in 1902.

Apparatus and species.	Beaufort.		Charleston.		Georgetown.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Drum					1,200	$36	1,200	$36
Flounders					500	20	500	20
Mullet					5,000	150	5,000	150
Squeteague					800	40	800	40
Striped bass					500	30	500	30
Sturgeon					1,800	90	1,800	90
Caviar					200	100	200	100
Whiting					1,200	72	1,200	72
Total					11,200	538	11,200	538
Lines:								
Amber fish			5,000	$150			5,000	150
Bastard snapper			25,000	640			25,000	640
Grouper			41,000	1,025			41,000	1,025
Jew-fish			9,500	238			9,500	238
Red snapper			10,100	303			10,100	303
Sea bass			263,700	11,588			263,700	11,588
Total			354,300	13,944			354,300	13,944
Dredges:								
Oyster			11,200	320			11,200	320
Tongs and grabs:								
Oyster	228,900	$4,245	321,300	10,445			550,200	14,690
Grand total	228,900	4,245	686,800	24,709	11,200	538	926,900	29,492

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of South Carolina in 1902.

Apparatus and species.	Beaufort.		Berkeley.		Charleston.		Georgetown.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:										
Blue-fish	1,000	$40							1,000	$40
Cat-fish							500	$15	500	15
Channel bass	4,000	120			49,000	$1,960			53,000	2,080
Croaker							2,000	80	2,000	80
Flounders							400	16	400	16
Hickory shad					800	16			800	16
Mullet	5,000	200			32,000	1,280	84,600	1,792	121,600	3,272
Sea bass	2,000	70							2,000	70
Shad					20,000	1,200			20,000	1,200
Spot					2,800	84	1,000	40	3,800	124
Squeteague					31,000	1,550	2,000	120	33,000	1,670
Striped bass					6,000	480			6,000	480
Whiting	1,000	30					600	36	1,600	66
Prawn	3,000	150							3,000	150
Shrimp					10,000	700			10,000	700
Terrapin	3,355	750			18,125	3,825			21,480	4,575
Total	19,355	1,360			169,725	11,095	91,100	2,099	280,180	14,554

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of South Carolina in 1902—Continued.

Apparatus and species.	Beaufort.		Berkeley.		Charleston.		Georgetown.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:										
Hickory shad					3,000	$60	26,800	$1,340	29,800	$1,400
Mullet							6,000	180	6,000	180
Shad					70,000	4,375	344,133	15,207	414,133	19,582
Striped bass					3,000	240	300	18	3,300	258
Squeteague							400	24	400	24
Sturgeon			12,000	$840	40,000	1,600	30,150	1,206	82,150	3,646
Whiting							500	30	500	30
Caviar			600	270	4,000	1,800	5,400	3,240	10,000	5,310
Total			12,600	1,110	120,000	8,075	413,683	21,245	546,283	30,430
Lines:										
Channel bass					49,000	1,470			49,000	1,470
Croaker	3,000	$120			22,000	440			25,000	560
Drum	43,500	435			30,000	900	500	25	74,000	1,360
Flounders							1,000	30	1,000	30
Jew-fish					70,000	3,500			70,000	3,500
Pompano					5,000	500			5,000	500
Sailor's choice					7,800	312			7,800	312
Sea bass	1,500	75			440,345	15,531	2,000	100	443,845	15,706
Sharks					90,000	1,800			90,000	1,800
Sheepshead	650	32			25,000	1,000	1,000	50	26,650	1,082
Spot					18,000	360			18,000	360
Squeteague					50,000	1,250	1,500	75	51,500	1,325
Whiting	20,000	800			580,000	29,000	3,000	150	603,000	29,950
Crab	1,200	45			95,000	950			96,200	995
Total	69,850	1,507			1,482,145	57,013	9,000	430	1,560,995	58,950
Cast nets:										
Mullet	6,000	180							6,000	180
Shrimp	8,500	340			348,000	11,412			356,500	11,752
Total	14,500	520			348,000	11,412			362,500	11,932
Tongs and hoes:										
Oyster	560,000	6,400			1,757,000	63,500	101,500	3,200	2,418,500	73,100
Clam					80,000	7,500	145,064	5,440	225,064	12,940
Total	560,000	6,400			1,837,000	71,000	246,564	8,640	2,643,564	86,040
Grabs:										
Oyster	1,848,000	30,350							1,848,000	30,350
Without apparatus:										
Terrapin					6,041	1,275			6,041	1,275
Grand total	2,511,705	40,137	12,600	1,110	3,962,911	159,870	760,347	32,414	7,247,563	233,531

THE WHOLESALE FISHERY TRADE.

In 1902 there were 9 firms in South Carolina engaged in the wholesale trade in fishery products. Of this number, 4 were in Charleston, and 5 in Georgetown. The firms in Charleston handle large quantities of fish from both fresh and salt water, and also oysters, clams, terrapin, and shrimp; those in Georgetown deal almost exclusively in shad and sturgeon.

Table showing, by counties, the number of persons employed and the capital invested in the wholesale fishery trade of South Carolina in 1902.

Items.	Charleston.		Georgetown.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Establishments	4	$29,150	5	$5,800	9	$34,950
Cash capital		21,600		7,200		28,800
Employees	23		21		44	
Total		50,750		13,000		63,750

THE CANNING INDUSTRY.

The canning industry of South Carolina is much more extensive than it was in 1897, when there were only 3 canneries, valued at $4,700. The number of persons employed was 133, and the output was valued at $21,136. In 1902 there were 9 canneries in operation, valued at $50,300. The number of persons employed was 1,477, and the products prepared, consisting of canned oysters, clams, clam juice, shrimp, and mullet, and salted mullet and mullet roe, were valued at $374,086.

Table showing the extent of the canning industry, and of the salting of mullet and mullet roe in South Carolina in 1902.

Items.	No.	Value.
Establishments	9	$50,300
Cash capital		124,500
Employees	1,477	
Raw products utilized:		
Oysters ... bushels	994,992	131,177
Clams ... do	15,600	4,680
Shrimp ... pounds	1,000	30
Mullet ... do	74,600	1,492
Prepared products:		
Oysters ... 1-lb. cans	4,426,728	274,269
Oysters ... 2-lb. cans	711,396	91,412
Clams ... 1-lb. cans	77,952	5,197
Clam juice ... do	13,392	725
Shrimp ... do	768	80
Mullet ... do	12,768	798
Mullet, salted ... pounds	50,500	1,515
Mullet roe ... do	900	90
Total		374,086

FISHERIES OF GEORGIA.

The fisheries of Georgia in 1902 gave employment to 2,286 persons, of whom 418 were on fishing vessels, 1,256 on boats in the shore fisheries, and 612 were shoresmen in the wholesale fishery trade and oyster-canning industry.

The investment in the fisheries amounted to $342,150. The number of vessels engaged was 105, valued at $52,950; their net tonnage was 1,340 tons, and the value of their outfit was $26,035. The number of boats in the shore fisheries was 736, valued at $21,574. The fishing apparatus used on vessels and boats was valued at $21,679, and the shore and accessory property at $86,912. The cash capital utilized was $133,000.

The products amounted to 11,102,610 pounds, having a value to the fishermen of $359,081. The species secured in largest quantities were oysters, 1,224,000 bushels, $220,467; shad, 1,029,050 pounds, $75,189; shrimp and prawn, 344,127 pounds, $8,408; cat-fish, 288,550 pounds, $6,838; mullet, 125,800 pounds, $2,576, and red snappers, 125,000 pounds, $7,500.

Compared with 1897 the fisheries of this state in 1902 showed an increase of 417 in persons employed, $57,286 in capital invested, and

6,109,510 pounds, or 122.35 per cent, in quantity, and $188,476, or 110.47 per cent, in value of the products.

Oyster fishery.—The oyster is the most valuable product taken in the waters of Georgia. The total catch in 1902 by vessels and small boats aggregated 1,224,000 bushels, valued at $220,467, an increase over 1897 of 737,366 bushels and $133,758, or 151.52 per cent in quantity and 154.26 per cent in value. The number of vessels engaged in oystering was 105, valued at $52,950, with a total of 418 men; the apparatus in use consisted of tongs and grabs. The catch by vessels was 891,500 bushels, valued at $132,647. In the shore fisheries 233 boats were used, including 3 barges and 1 small steamer. The persons engaged numbered 425, many of whom were employed in other fisheries after the close of the oyster season, and the catch was 332,500 bushels, valued at $87,820.

The oysters in Georgia are obtained chiefly from the natural beds, and are known as "coon" or "bunch" oysters. Many of the oyster reefs are located above low-water mark, and when the tide recedes the oysters are entirely exposed, which greatly facilitates the work of gathering them. The fishermen visit these beds with small sailing vessels, from which, after coming to anchor, large skiffs are taken and moored over the oyster grounds. At low tide the men land on the oyster beds, gather the oysters, and transfer them to the vessels.

In recent years more attention has been given to the cultivation of oysters in this state, and a fine quality for the raw or open stock has been secured; but owing to the remoteness of the oyster grounds from the habitation of the owner, their general cultivation becomes a rather hazardous undertaking, since to maintain the beds in any satisfactory state of productiveness calls for constant care and watchfulness against depredators. There is very little doubt, however, that in the years to come private oyster culture will have to be resorted to on a large scale in this state if the oyster supply is to be maintained.

After many experiments the oyster planters of Georgia have determined that the best bottoms are those containing mud of a semi-liquid consistency, which prevents the starfish from crawling about, and also smothers the drill. The drill (*Urosalpinx cinerea*) does very little damage to oysters in shallow water, but is rather troublesome in deep water. The salt-water drum is considered the greatest enemy of the young oyster, destroying many thousands annually.

The local demand for shucked or opened oysters for the Savannah market is supplied from the catch of small boats under five tons, the owners of which for the most part reside in the southeastern part of Chatham County, on Skidway Island. The oysters are taken from the Skidway River, Tybee River and creek, and Halfmoon River, and the greater part of the catch is gathered at low tide when the oysters are exposed. After securing a load the fisherman returns to

his home, where, with the assistance of his family, he opens the oysters and later conveys them to market to dispose of them to the wholesale dealers. In 1902, 52,500 gallons were sold in this way at 80 cents per gallon, netting $42,000.

The enactment of a law prohibiting the shipment of oysters out of the state for canning purposes affords protection to those engaged in the canning industry. Quite recently a factory located at St. Marks, Fla., which, before the enactment of this law, had received its supply of oysters from Georgia, was forced to move into the state, and is now located near Brunswick.

The canning of "cove" oysters has received a great impetus since 1897, as new markets have been opened for the product of the canneries, which is now shipped to many of the Western States, a large quantity finding its way into the mining camps of Alaska. One canner recently sold $50,000 worth of his product in California. The oysters used in canning are about 90 per cent "coon" or "bunch" oysters and 10 per cent large oysters taken in deep water.

Shad fishery.—The shad is the most prominent species of fish occurring in the waters of this state, and its capture constitutes one of the leading industries of the coastal rivers of Georgia, giving employment to over 400 men during the fishing season. The product of the shad fisheries in 1902 amounted to 1,029,050 pounds, valued at $75,189, an increase over 1897 of 241,500 pounds and $28,484, or about 31 per cent in weight, and 61 per cent in value. The catch is greater in quantity and value than that of any other species taken in the fisheries of Georgia except the oyster. Of the various rivers of the state to which shad resort, the most important are, in the order named, the Ogeechee, Savannah, and the Altamaha.

The commercial fisheries of the Ogeechee River are prosecuted in the counties of Chatham and Bryan, and though the fish ascend the river a long distance above the limits of these counties, the industry is unimportant and the few fish taken are used locally. The total catch in this river in 1902 was 142,275 shad, weighing 569,100 pounds, valued at $35,569; this represents more than half of the quantity and nearly half of the value of the entire catch of shad in the waters of the state. About 300 men were employed, using 149 nets and an equal number of boats. The larger portion of the catch, or 425.100 pounds, with a value of $26,259, was taken on the Chatham County side of the river, where 218 men were engaged. The only apparatus used was the gill net. The nets average about 150 yards each, with a 5½-inch mesh, and are from 35 to 50 meshes deep. The nets are fished day and night during the season, and the best catches are made on the slack of the ebb tide and on the flood.

The shad season on the Ogeechee River opens about January 15, at which time the fishermen erect tents and other means of shelter along

the river at various localities and camp until the run is over, in the latter part of March. The catch is shipped to Savannah, whence it is distributed to the northern markets.

The shad fisheries of the Savannah River show a decline in recent years. In the opinion of some of the fishermen this condition has been due partly to muddy water and the construction of a jetty at the mouth of the river. The fish seem to have largely forsaken the main channel, and the greater part of the catch is now taken in what is known locally as Back River, an arm or cut-off of the main stream below the city of Savannah. In 1902 the number of shad obtained was 63,000, weighing 252,000 pounds, and valued at $15,750. The catch was taken by 120 fishermen, using 60 boats and 96 gill nets, the latter having a 5-inch mesh and an average length of about 600 feet.

With improved shipping facilities the shad fisheries of the Altamaha River have grown in importance during recent years. In 1902 the catch amounted to 111,950 pounds, valued at $13,270. The shad are all taken in drift gill nets, between Doctortown and the mouth of the river. The fishing season on the Altamaha begins and ends earlier than in any of the rivers previously mentioned, the period being fixed by law from January 1 to April 20.

Many of the fishermen make their headquarters at and below Darien during the shad season, where buyers for the northern markets are located. During the early part of the season of 1903 large prices were obtained by the fishermen, roe shad selling for $2.50 each and buck shad for $1 each. The prices for the season averaged 60 cents each for roe shad and 25 cents each for buck shad.

The fishery on the Georgia side of St. Marys River is of little consequence. In 1902 a few set gill nets were fished, in which were taken 11,200 shad, or 56,000 pounds, valued at $5,600. These were marketed at Oakwell, Ga.

Terrapin fishery.—The diamond-back terrapin fishery of Georgia shows a slight falling off as compared with the returns for 1897. In 1902 the catch consisted of 1,282 dozen terrapin, weighing 33,308 pounds, and having a value to the fishermen of $11,136. The fishery is carried on principally by 188 men, with 121 boats, valued at $2,140, and 125 seines, valued at $4,656. There was also one vessel engaged, with two seines valued at $80, and a crew of 3 men. The boats usually start in the spring and make trips of two or three weeks' duration. When the fishing ground is reached one of the crew raps sharply on the side of the boat with a stick, the noise causing the terrapin to rise to the surface. Their whereabouts thus disclosed, the seine is set around them. The seines used are generally from 40 to 65 fathoms long and 45 meshes deep, the meshes being 5½ inches stretched. In July, August, and part of September terrapin are taken by "bogging."

The eggs, which average from about 8 to 10 in number, are laid in

April and May and are deposited in the sand. Few terrapin are bought during the spawning season (April and May), as they are not apt to survive the summer in crawls. Those taken in July or later are more hardy, and few die before the time to market them. Terrapin are graded by the dealers into "counts," 6 to 8 inches long, or an average of 6½ inches, weighing 2½ pounds each; "three-fourths," 5½ to 6 inches long, weighing 1½ pounds each; "one-half," 5 to 5½ inches long, weighing 11 pounds per dozen; and "bulls," 4 to 4½ inches long, weighing one-half pound each.

Fishery legislation.—An act prohibiting the catching of sturgeon in the waters of the State for a period of five years was approved December 5, 1901. It has also been made illegal to use any kind of nets, except cast nets, for any species from June 1 to September 1 each year.

Statistics.—The following tables show the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of Georgia in 1902:

Persons engaged.

How engaged.	No.
In vessel fisheries	418
In shore or boat fisheries	1,256
Shoresmen	612
Total	2,286

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	105	$52,950	Apparatus—shore fisheries:		
Tonnage	1,340		Cast nets	139	$695
Outfit		26,035	Seines	137	5,156
Boats fishing	736	21,574	Lines		414
Apparatus—vessel fisheries:			Oyster tongs	260	1,560
Oyster tongs	180	1,156	Oyster grabs	127	153
Oyster grabs	382	493	Clam tongs and hoes	26	72
Lines		225	Shore and accessory property		86,912
Seines	2	80	Cash capital		133,000
Apparatus—shore fisheries:					
Pound nets	7	1,260	Total		342,150
Gill nets	347	10,385			

Table of products.

Species.	Total. Lbs.	Total. Value.	Species.	Total. Lbs.	Total. Value.
Alewives	22,500	$450	Shad	1,029,050	$75,189
Black bass	1,250	62	Sheepshead	50,000	2,500
Carp	50,000	1,500	Squeteague	82,550	4,107
Cat-fish	288,550	6,838	Striped bass	2,500	175
Channel bass	34,900	1,607	Sun-fish	2,200	102
Croaker	28,825	870	Whiting	57,425	2,608
Drum	25,100	1,006	Shrimp	68,127	2,658
Eel	5,300	106	Prawn	276,000	5,750
Flounders	2,600	69	Crab, hard	80,000	3,150
Groupers	50,000	1,500	Terrapin	33,308	11,136
Hickory shad	1,800	90	Turtle	975	20
Mullet	125,800	2,576	Oyster	[a] 8,568,000	220,467
Perch	4,000	120	Clam	[b] 10,000	825
Pike	350	18			
Red snapper	125,000	7,500	Total	11,102,610	359,081
Sea bass	76,500	6,082			

[a] 1,224,000 bushels. [b] 1,250 bushels.

THE FISHERIES CONSIDERED BY COUNTIES.

The coast fisheries of Georgia are carried on in 7 counties, comprising the 6 fronting on the Atlantic Ocean, and Wayne County on the south side of the Altamaha River. They are of greater importance in Chatham County than in all of the other counties combined. The number of persons employed in that county was 1,429, the investment was $241,092, and the products amounted to 8,313,745 pounds, valued at $270,488. This considerably exceeded the entire yield for the State in 1897, the increase being principally in the catch of oysters. In Wayne County the fisheries are exclusively for shad.

Table showing, by counties, the number of persons employed in the fisheries of Georgia in 1902.

Counties.	Vessel fishermen.	Boat fishermen.	Shoresmen.	Total.
Bryan		80		80
Camden		63		63
Chatham	342	700	387	1,429
Glynn	70	201	180	451
Liberty		25	45	70
McIntosh	6	163		169
Wayne		24		24
Total	418	1,256	612	2,286

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Georgia in 1902.

Items.	Bryan.		Camden.		Chatham.		Glynn.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing					84	$40,650	18	$11,800
Tonnage					1,101		210	
Outfit						21,745		3,955
Boats fishing	42	$440	35	$970	372	15,944	157	1,770
Apparatus—vessel fisheries:								
Oyster tongs					162	972	18	184
Oyster grabs					307	385	69	99
Lines						225		
Seines					2	80		
Apparatus—shore fisheries:								
Pound nets	3	540			4	720		
Gill nets	40	1,400	8	120	205	6,215	31	930
Cast nets					100	500	35	175
Seines			19	716	39	1,560	34	1,080
Lines						325		23
Oyster tongs					222	1,332	23	138
Oyster grabs			15	19	52	49	33	49
Clam tongs and hoes					12	65	10	5
Shore and accessory property		300		625		60,325		20,442
Cash capital						90,000		30,000
Total		2,680		2,450		241,092		70,650
Items.	**Liberty.**		**McIntosh.**		**Wayne.**		**Total.**	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			3	$500			105	$52,950
Tonnage			29				1,340	
Outfit				335				26,035
Boats fishing	21	$1,130	97	1,200	12	$120	736	21,574
Apparatus—vessel fisheries:								
Oyster tongs							180	1,156
Oyster grabs			6	9			382	493
Lines								225
Seines							2	80
Apparatus—shore fisheries:								
Pound nets							7	1,260
Gill nets	5	150	46	1,210	12	360	347	10,385
Cast nets			4	20			139	695
Seines			45	1,800			137	5,156
Lines				96				444
Oyster tongs	15	90					260	1,560
Oyster grabs	17	21	10	15			127	153
Clam tongs and hoes	4	2					26	72
Shore and accessory property		5,020		200				86,912
Cash capital		13,000						133,000
Total		19,413		5,385		480		342,150

Table showing, by counties and species, the yield of the fisheries of Georgia in 1902.

Species.	Bryan.		Camden.		Chatham.		Glynn.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives	10,000	$200			12,500	$250		
Black bass	250	12			1,000	50		
Carp					50,000	1,500		
Cat-fish	8,550	128			264,500	6,140	7,500	$150
Channel bass			6,900	$207	26,000	1,300	2,000	100
Croaker					23,125	756	5,000	100
Drum			2,400	72	16,000	800	6,700	134
Eel					5,300	106		
Flounders			800	24			1,800	45
Groupers					50,000	1,500		
Hickory shad	600	30			1,200	60		
Mullet			48,000	1,440	68,000	940	7,000	140
Perch					4,000	120		
Pike	150	8			200	10		
Red snapper					125,000	7,500		
Sea bass					73,000	5,840	3,000	210
Shad	144,000	9,000	56,000	5,600	677,100	42,319	40,000	5,000
Sheepshead					50,000	2,500		
Squeteague			3,000	90	42,000	2,140	32,250	1,612
Striped bass	1,000	70			1,500	105		
Sun-fish	500	25			1,700	77		
Whiting					43,000	2,210	13,775	383
Shrimp			127	9	28,000	1,150	40,000	1,499
Prawn			276,000	5,750				
Crab					60,000	2,400	20,000	750
Terrapin			2,400	800	11,420	4,320	9,600	2,720
Turtle	475	10			500	10		
Oyster			77,000	1,100	6,675,900	186,210	1,174,600	19,777
Clam					2,800	175	800	50
Total	165,525	9,483	472,627	15,092	8,313,745	270,488	1,364,025	32,670

Species.	Liberty.		McIntosh.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives							22,500	$450
Black bass							1,250	62
Carp							50,000	1,500
Cat-fish			8,000	$420			288,550	6,838
Channel bass							34,900	1,607
Croaker			700	14			28,825	870
Drum							25,100	1,006
Eel							5,300	106
Flounders							2,600	69
Groupers							50,000	1,500
Hickory shad							1,800	90
Mullet			2,800	56			125,800	2,576
Perch							4,000	120
Pike							350	18
Red snapper							125,000	7,500
Sea bass			500	32			76,500	6,082
Shad	6,000	$600	86,750	10,750	19,200	$1,920	1,029,050	75,189
Sheepshead							50,000	2,500
Squeteague			5,300	265			82,550	4,107
Striped bass							2,500	175
Sun-fish							2,200	102
Whiting			650	15			57,425	2,608
Shrimp							68,127	2,658
Prawn							276,000	5,750
Crab							80,000	3,150
Terrapin			9,888	3,296			33,308	11,136
Turtle							975	20
Oyster	490,000	10,500	150,500	2,880			8,568,000	220,467
Clam	6,400	600					10,000	825
Total	502,400	11,700	265,088	17,728	19,200	1,920	11,102,610	359,081

THE PRODUCTS BY APPARATUS.

Vessel fisheries.—The vessel fisheries of Georgia are prosecuted chiefly in Chatham County, but also to a limited extent in Glynn and McIntosh counties. The vessels are all engaged in the oyster fishery, and the principal forms of apparatus employed are oyster tongs and grabs. Lines are used in taking red snapper, groupers, and sea bass, and seines in the capture of terrapin. The number of vessels has increased since 1897 from 51, valued at $21,425, to 105, valued at $52,950; and the catch from 2,081,870 pounds, valued at $32,577, to 6,489,600 pounds, valued at $147,887. The catch in 1897 consisted wholly of oysters, but in 1902 it included 6,240,500 pounds, or 891,500 bushels, of oysters, valued at $132,647, 248,000 pounds of red snapper, groupers, and sea bass, valued at $14,800, and 1,100 pounds of terrapin, valued at $400.

Shore fisheries.—The apparatus employed in the shore fisheries consisted of pound nets, gill nets, cast nets, seines, lines, oyster tongs and grabs, clam tongs and hoes. The catch aggregated 4,613,010 pounds, valued at $211,194.

The catch taken with oyster tongs and grabs amounted to 332,500 bushels of oysters, valued at $87,820. Gill nets were next in importance, the yield being 1,075,325 pounds, valued at $77,164. The species secured in largest quantities in gill nets were shad, 1,029,050 pounds, valued at $75,189, and squeteague, 28,750 pounds, valued at $1,437. The catch with lines was 622,525 pounds, valued at $21,388, consisting chiefly of cat-fish, crabs, carp, sheepshead, squeteague, whiting, croaker, and channel bass; with seines, 404,435 pounds of various species, valued at $19,640; with cast nets, 126,800 pounds, valued at $3,339; with pound nets, 46,425 pounds, valued at $1,018; and with clam tongs and rakes, 10,000 pounds, or 1,250 bushels of hard clams, valued at $825.

The following tables show the quantity and value of products taken with each form of apparatus in the vessel and shore fisheries of Georgia in 1902:

Table showing, by counties, the yield of the vessel fisheries of Georgia in 1902.

Apparatus and species.	Chatham.		Glynn.		McIntosh.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Oyster tongs and grabs:								
Oyster	5,303,900	$118,240	828,100	$12,427	108,500	$1,980	6,240,500	$132,647
Lines:								
Groupers	50,000	1,500					50,000	1,500
Red snapper	125,000	7,500					125,000	7,500
Sea bass	73,000	5,840					73,000	5,840
Total	248,000	14,840					248,000	14,840
Seines:								
Terrapin	1,100	400					1,100	400
Grand total	5,553,000	133,480	828,100	12,427	108,500	1,980	6,489,600	147,887

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Georgia in 1902.

Apparatus and species.	Bryan.		Camden.		Chatham.		Glynn.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Alewives	10,000	$200			12,500	$250		
Black bass	250	12			200	10		
Cat-fish	8,550	128			10,000	150		
Pike	150	8			200	10		
Striped bass	1,000	70			1,500	105		
Sun-fish	500	25			600	30		
Turtle	475	10			500	10		
Total	20,925	453			25,500	565		
Gill nets:								
Channel bass							2,000	$100
Drum							3,000	60
Flounders							1,800	45
Hickory shad	600	30			1,200	60		
Mullet							2,800	56
Shad	144,000	9,000	56,000	$5,600	677,100	42,319	40,000	5,000
Squeteague							27,250	1,362
Whiting							5,275	158
Total	144,600	9,030	56,000	5,600	678,300	42,379	82,125	6,781
Cast nets:								
Channel bass					6,000	300		
Mullet					68,000	940	4,200	84
Whiting					10,000	500		
Shrimp					28,000	1,150	5,000	187
Total					112,000	2,890	9,200	271
Seines:								
Channel bass			6,900	207				
Drum			2,400	72				
Flounders			800	24				
Mullet			48,000	1,440				
Squeteague			3,000	90			35,000	1,312
Shrimp			127	9				
Prawn			276,000	5,750				
Terrapin			2,400	800	10,320	3,920	9,600	2,720
Total			339,627	8,392	10,320	3,920	44,600	4,032
Lines:								
Black bass					800	40		
Carp					50,000	1,500		
Cat-fish					254,500	5,990	7,500	150
Channel bass					20,000	1,000		
Croaker					23,125	756	5,000	100
Drum					16,000	800	3,700	74
Eel					5,300	106		
Perch					4,000	120		
Sea bass							3,000	210
Sheepshead					50,000	2,500		
Squeteague					42,000	2,140	5,000	250
Sun-fish					1,100	47		
Whiting					33,000	1,710	8,500	225
Crab					60,000	2,400	20,000	750
Total					559,825	19,109	52,700	1,759
Oyster tongs and grabs:								
Oysters			77,000	1,100	1,372,000	67,970	346,500	7,350
Clam tongs and hoes:								
Clam					2,800	175	800	50
Grand total	165,525	9,483	472,627	15,092	2,760,745	137,008	535,925	20,243

Table showing by counties, apparatus, and species the yield of the shore fisheries of Georgia in 1902—Continued.

Apparatus and species.	Liberty.		McIntosh.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Alewives							22,500	$450
Black bass							450	22
Cat-fish							18,550	278
Pike							350	18
Striped bass							2,500	175
Sun-fish							1,100	55
Turtle							975	20
Total							46,425	1,018
Gill nets:								
Channel bass							2,000	100
Croaker			200	$4			200	4
Drum							3,000	60
Flounders							1,800	45
Hickory shad							1,800	90
Mullet			300	6			3,100	62
Sea bass			200	14			200	14
Shad	6,000	$600	86,750	10,750	19,200	$1,920	1,029,050	75,189
Squeteague			1,500	75			28,750	1,437
Whiting			150	5			5,425	163
Total	6,000	600	89,100	10,854	19,200	1,920	1,075,325	77,164
Cast nets:								
Channel bass							6,000	300
Croaker			500	10			500	10
Mullet			2,500	50			74,700	1,074
Sea bass			300	18			300	18
Squeteague			1,800	90			1,800	90
Whiting			500	10			10,500	510
Shrimp							33,000	1,337
Total			5,600	178			126,800	3,339
Seines:								
Channel bass							6,900	207
Drum							2,400	72
Flounders							800	24
Mullet							48,000	1,440
Squeteague							3,000	90
Shrimp							35,127	1,321
Prawn							276,000	5,750
Terrapin			9,888	3,296			32,208	10,736
Total			9,888	3,296			404,435	19,610
Lines:								
Black bass							800	40
Carp							50,000	1,500
Cat-fish			8,000	420			270,000	6,560
Channel bass							20,000	1,000
Croaker							28,125	856
Drum							19,700	874
Eel							5,300	106
Perch							4,000	120
Sea bass							3,000	210
Sheepshead							50,000	2,500
Squeteague			2,000	100			49,000	2,490
Sun-fish							1,100	47
Whiting							41,500	1,935
Crab							80,000	3,150
Total			10,000	520			622,525	21,388
Oyster tongs and grabs:								
Oysters	490,000	10,500	42,000	900			2,327,500	87,820
Clam tongs and hoes:								
Clam	6,400	600					10,000	825
Grand total	502,400	11,700	156,588	15,748	19,200	1,920	4,613,010	211,194

WHOLESALE FISHERY TRADE.

The wholesale trade in fresh fish, oysters, etc., in Georgia, centers chiefly at Savannah. In 1902, 6 firms, employing 90 persons, were engaged in this branch of the industry. The value of the property utilized was $40,000, and the cash capital amounted to $44,000.

Table showing the persons employed and capital invested in the wholesale fishery trade of Georgia in 1902.

Items.	No.	Value.
Establishments	6	$40,000
Cash capital		44,000
Wages paid		19,020
Employees	90	

OYSTER-CANNING INDUSTRY.

There has been a large increase since 1897 in the extent of the oyster-canning industry of this state. The number of canneries has increased from 3, worth $34,000, to 6, worth $44,800; the number of persons employed, from 383 to 522; the cash capital, from $50,000 to $89,000; the quantity of oysters used, from 363,998 bushels, costing $49,993, to 582,200 bushels, costing $78,425, and the value of the output, including canned and other products, from $127,148 to $202,049.

In 1902, 3 canneries were located in Chatham County, 2 in Glynn County, and 1 in Liberty County. The products sold consisted of 1,974,004 1-pound cans of oysters, valued at $123,075; 620,000 2-pound cans, valued at $77,099, and 250,000 bushels of oyster shells, valued at $1,875.

Table showing the oyster-canning industry of Georgia in 1902.

Items.	No.	Value.
Establishments	6	$44,800
Cash capital		89,000
Wages		45,625
Employees	522	
Oysters utilized ... bushels	582,200	78,425
Oysters canned:		
One-pound cans ... number	1,974,004	123,075
Two-pound cans ... do	620,000	77,099
Oyster shells sold ... bushels	250,000	1,875

FISHERIES OF EASTERN FLORIDA.

The east coast of Florida is very favorably situated for carrying on commercial fishing. It has numerous rivers, bays, and lagoons indenting the 450 miles of straight shore line, the principal ones being St. Marys River, which forms the dividing line between Florida and Georgia, Nassau River and Sound, St. Johns River, Matanzas River, Halifax River, Mosquito Lagoon or Hillsboro River, Indian River,

St. Lucie Sound, Lake Worth, and Biscayne Bay. St. Marys and St. Johns are the only real rivers, the others being merely lagoons or arms of the sea, from which they are separated by low sandy bars. These waters are favorite feeding and breeding grounds for marine species and for anadromous species, such as alewives and shad.

The principal fishing towns are Fernandina, on St. Marys River; Mayport, Fulton, New Berlin, Jacksonville, Palatka, and Sanford, on St. Johns River; St. Augustine, on Matanzas River; New Smyrna, on Mosquito Lagoon; Aurantia, Titusville, Cocoa, Grant, and Sebastian, on Indian River; Fort Pierce and Eden, on St. Lucie Sound; West Palm Beach, on Lake Worth; Lantana and Fort Lauderdale, on the coast, and Miami, on Biscayne Bay.

The fisheries of eastern Florida are second in importance in the South Atlantic States, being surpassed by North Carolina only. Recent figures are not available for comparison with those of 1902. In 1890, when the last complete canvass was made, 7,463,531 pounds of fishery products, valued at $219,870, were taken, and in 1902, 19,584,265 pounds, valued at $477,868, a gain of 12,120,734 pounds and $257,998. The increases are principally in the alewife, black-bass, cat-fish, mullet, pompano, squeteague, oyster, and prawn fisheries, while the channel-bass, drum, and shad fisheries have decreased and the sturgeon has disappeared completely. In persons employed there was an increase from 1,404 in 1890 to 2,698 in 1902, a difference of 1,294, while the total investment increased from $142,105 in 1900 to $354,835 in 1902, a difference of $212,730.

For many years the fishermen of the eastern coast of Florida failed to avail themselves of the prolific snapper banks which lie a short distance off their shores. These banks were fished mainly by New England vessels, which landed their catch at Savannah. One vessel from Fernandina now engages in the fishery, and it is probable that others will follow the example. A few other vessels from Nassau County engage in oystering, while one vessel in Dade County uses purse seines for Spanish mackerel during the winter and early spring. These are all new features, as there were no vessel fisheries in this section of the state at the time of the last canvass.

The fisheries of Indian River suffered severely last year because of an epidemic, which began about the middle of September and continued until the last of the month, killing thousands of fish. The principal mortality was in that section of the river lying between the Narrows and Sebastian. A southeast wind seemed to drive the diseased fish toward Sebastian, some even going so far as Grant. All species seemed to be affected, but the mullet suffered least.

A female sturgeon, full of eggs, weighing about 175 pounds, and measuring about 6 feet in length, was caught in a gill net in the Indian River, near Fort Pierce, in January, 1903. Six shad were taken in

gill nets in the St. Lucie River on February 18, 1902—a rather unusual occurrence.

Quite an industry is still maintained on the rivers and the interior lakes and streams in the hunting and trapping of alligators and otters, which are brought to the coast and sold at Cutler, Miami, Fort Lauderdale, West Jupiter, Fort Pierce, and Titusville. The buyers either ship direct to the tanners and furriers in Newark, N. J., or to the wholesalers in Jacksonville.

A new industry is the gathering of periwinkles near Pablo Beach, in Duval County. These are taken by means of shovels with wire scoops, and are used for making what is locally called "donack" soup. The periwinkles, in the shell, are put into a pot and boiled and then strained, the shells being thrown away.

In Nassau County are to be found a few pens for holding terrapin for market.

An effort is being made by parties at Miami to introduce to the trade dried king-fish, and an excellent article has been prepared. Heretofore the principal market for king-fish has been Havana, Cuba, which would take only the fresh product, and as the fish are quite abundant in the season, there has nearly always been an oversupply, thus cutting the fisherman's price to a very low figure. If a demand for dried king-fish could be developed, the fishery might be greatly increased.

The East Coast Railway is now being extended below Miami, and it is probable that it will be continued on to Cape Sable. This will open up the lower part of Dade County and will doubtless cause a considerable expansion of the fisheries in that region, which have hitherto not been prosecuted to any great extent on account of the lack of a convenient market.

Owing to the constantly increasing demand for cat-fish in the west, sea cat-fish are now being utilized quite largely, as the river cat-fish can not be secured in sufficient quantity. This is a departure, sea cat-fish having been hitherto either killed or thrown back into the water when taken on the lines or in the nets of the fishermen.

The following tables show in condensed form the condition of the fisheries in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	38
On vessels transporting	5
Shore or boat fisheries	2,224
Shoresmen	431
Total	2,698

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	7	$6,225	Apparatus—shore fisheries—Continued:		
Tonnage	98		Cast nets	125	$693
Outfit		1,405	Lines		518
Vessels transporting	2	1,655	Tongs and rakes	117	743
Tonnage	18		Spears	20	10
Outfit		750	Guns	167	2,605
Boats	1,400	71,710	Traps, otter	2,915	2,351
Apparatus—vessel fisheries:			Grabs	80	101
Purse seines	2	800	Shovels	3	2
Lines		42	Shore and accessory property		80,490
Grabs	19	23	Cash capital		115,750
Apparatus—shore fisheries:					
Haul seines	143	10,477	Total		354,835
Gill nets	1,781	58,435			
Pound nets	1	50			

Table of products.

Species.	Lbs.	Value.	Species.	Lbs.	Value.
Alewives	405,697	$1,596	Sailor's choice	43,583	$831
Angel-fish	4,550	71	Sea bass	29,800	1,045
Borracuda	1,000	50	Sergeant-fish	2,828	43
Black bass	314,310	12,449	Shad	1,819,431	124,760
Blue-fish	79,500	3,548	Sheepshead	404,251	7,400
Bonito	7,120	212	Spanish mackerel	659,088	34,374
Bream	643,514	14,149	Spot	32,451	825
Cat-fish	616,742	12,152	Squeteague	898,563	26,967
Channel bass	114,635	3,175	Strawberry bass	221,606	5,166
Crevallé	5,900	95	Whiting	82,150	3,657
Croaker	6,593	191	Yellow-tail	1,366	21
Drum	20,250	640	Alligator hides	[a] 100,687	13,538
Flounders	49,380	1,392	Clam, hard	[b] 5,200	325
Groupers	26,910	486	Crab, hard	[c] 6,066	152
Grunts	33,442	755	Oyster	[d] 2,163,483	37,188
Hickory shad	58,666	2,651	Otter skins	[e] 2,927	17,352
King-fish	31,790	318	Periwinkle	5,400	120
Mangrove snapper	8,043	124	Prawn	3,012,360	62,896
Mullet	7,340,916	62,347	Shrimp	494	34
Mutton-fish	4,740	96	Terrapin	[f] 3,910	1,164
Permit	10,342	254	Turtle	12,200	787
Pig-fish	1,800	28	Tortoise shell	20	50
Pompano	265,231	21,835			
Porgy	5,300	159	Total	19,584,265	477,868
Red snapper	20,000	400			

[a] Represents 22,375 in number.
[b] Represents 650 bushels.
[c] Represents 18,198 in number.
[d] Represents 309,069 bushels.
[e] Represents 2,927 in number.
[f] Represents 1,480 in number.

THE FISHERIES CONSIDERED BY COUNTIES.

Commercial fishing in eastern Florida is carried on in six coastal counties (Nassau, Duval, St. John, Volusia, Brevard, and Dade), and two interior counties (Orange and Putnam). In persons employed, investment, and quantity of catch, Brevard County takes the lead, the value of the catch, however, being exceeded by Nassau County. Indian River is almost wholly within Brevard County. Nassau County is second in persons employed and quantity of catch, while Dade County is third in persons employed and second in value of investment. The greater part of the squeteague, and more than half of the mullet, were taken in Brevard County; all of the red snappers, nearly all of the prawn, and more than half of the oysters came from Nassau County. Duval County leads in the shad catch, Orange County in alewives, black bass, bream, cat-fish, and strawberry bass. Dade is first in the catch of blue-fish, grunt, king-fish, pompano, Spanish mackerel, otter, and alligator.

Table showing the number of persons employed in the fisheries of eastern Florida in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Nassau	25		320	172	517
Duval		2	364	8	374
Putnam			147	4	151
Orange			123	13	136
St. John			125	83	208
Volusia			204	10	214
Brevard			501	100	601
Dade	13	3	440	41	497
Total	38	5	2,224	431	2,698

Table showing, by counties, the apparatus and capital employed in the fisheries of the eastern coast of Florida in 1902.

Items.	Nassau.		Duval.		Putnam.		Orange.		St. John.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	6	$4,075								
Tonnage	82									
Outfit		805								
Vessels transporting			1	$1,230						
Tonnage			10							
Outfit				400						
Boats	222	5,500	172	7,255	73	$2,110	74	$2,095	95	$1,960
Apparatus—vessel fisheries:										
Lines		42								
Grabs	19	23								
Apparatus—shore fisheries:										
Haul seines	22	602	26	985	24	2,050	29	2,720	2	100
Gill nets	87	1,195	222	11,170	29	2,030	2	70	8	220
Pound nets			1	50						
Cast nets	33	198	15	90					20	120
Lines				35		20		35		20
Tongs and rakes			14	98					87	'565
Spears									20	10
Grabs	80	101								
Shovels			3	2						
Shore and accessory property		14,300		17,475		2,165		2,975		6,135
Cash capital		24,150		18,000		500		4,900		16,000
Total		50,991		56,790		8,875		12,795		25,130

Items.	Volusia.		Brevard.		Dade.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing					1	$2,150	7	$6,225
Tonnage					16		98	
Outfit						600		1,405
Vessels transporting					1	425	2	1,655
Tonnage					8		18	
Outfit						350		750
Boats	114	$3,340	316	$29,210	334	20,240	1,400	71,710
Apparatus—vessel fisheries:								
Purse seines					2	800	2	800
Lines								42
Grabs							19	23
Apparatus—shore fisheries:								
Haul seines	32	3,220	8	800			143	10,477
Gill nets	60	1,100	613	26,180	760	16,470	1,781	58,435
Pound nets							1	50
Cast nets	44	220	13	65			125	693
Lines		37		303		68		518
Tongs and rakes			8	40	8	40	117	743
Spears							20	10
Guns			32	480	135	2,125	167	2,605
Traps			720	320	2,195	2,031	2,915	2,351
Grabs							80	101
Shovels							3	2
Shore and accessory property		2,050		23,890		11,500		80,490
Cash capital		750		36,200		15,250		115,750
Total		10,717		117,488		72,049		354,835

Table showing, by counties and species, the yield of the fisheries of the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		Putnam.		Orange.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives							371,697	$1,238		
Black bass			6,600	$297	66,850	$2,674	172,860	6,938		
Bream			41,200	1,030	117,300	2,533	231,814	4,636		
Cat-fish			196,000	3,920	80,600	1,752	210,142	3,280		
Channel bass	10,000	$300	15,800	622					60,860	$1,824
Croaker			760	16					5,833	175
Drum	1,200	36	10,400	416					3,500	105
Flounders	2,000	60	1,850	55	950	24			37,700	1,132
Groupers	10,000	150								
Hickory shad			11,500	346	45,300	2,242	406	6		
Mullet	50,000	1,500	1,867,875	19,035			7,012	53	223,500	2,235
Pompano	500	50	260	26					550	56
Red snapper	20,000	400								
Sailor's choice			200	3					11,000	330
Sea bass	15,000	750							4,800	145
Shad	365,500	36,550	807,700	46,450	158,391	10,178	158,390	5,607	4,200	300
Sheepshead			250	7					20,100	647
Spot			2,010	74					19,090	575
Squeteague	5,000	200	71,250	2,245					29,500	1,044
Strawberry bass			10,400	260	39,700	1,108	114,406	2,288		
Whiting			40,300	1,615					26,100	1,045
Clam, hard									5,200	325
Crab, hard			4,400	110					1,666	42
Oyster	1,394,743	20,100	14,700	700					701,400	12,630
Periwinkle			5,400	120						
Prawn	2,791,260	58,151	211,200	4,400					9,900	345
Shrimp	494	34								
Terrapin	3,300	1,100								
Turtle					1,375	21				
Total	4,668,997	119,381	3,320,055	81,747	510,466	20,532	1,266,727	24,046	1,164,899	22,955

Species.	Volusia.		Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives	34,000	$358					405,697	$1,596
Angel-fish			3,650	$56	900	$15	4,550	71
Barracuda					1,000	50	1,000	50
Black bass	56,000	2,240	12,000	300			314,310	12,449
Blue-fish			18,950	674	60,550	2,874	79,500	3,548
Bonito			1,400	26	5,720	186	7,120	212
Bream	193,200	4,750	60,000	1,200			643,514	14,149
Cat-fish	110,000	2,400	20,000	800			616,742	12,152
Channel bass	1,200	24	26,500	401	275	4	114,635	3,175
Crevalle			5,600	86	300	9	5,900	95
Croaker							6,593	191
Drum	800	16	4,350	67			20,250	640
Flounders	1,200	32	4,080	65	1,600	24	49,380	1,392
Groupers			8,000	121	8,910	215	26,910	486
Grunts			10,300	156	23,142	599	33,442	755
Hickory shad	1,460	57					58,666	2,651
King-fish			800	8	30,990	310	31,790	318
Mangrove snapper			4,213	65	3,830	59	8,043	124
Mullet	347,000	2,690	4,825,544	36,670	19,985	164	7,340,916	62,347
Mutton-fish			1,450	22	3,290	74	4,740	96
Permit			6,250	125	4,092	129	10,342	254
Pig-fish			1,800	28			1,800	28
Pompano			125,110	10,010	138,811	11,693	265,231	21,835
Porgy					5,300	159	5,300	159
Red snapper							20,000	400
Sailor's choice	1,300	26	27,198	413	3,885	59	43,583	831
Sea bass	10,000	150					29,800	1,045
Sergeant-fish			2,443	38	385	5	2,828	43
Shad	325,250	25,675					1,819,431	124,760
Sheepshead	50,000	750	287,401	5,298	46,500	698	404,251	7,400
Spanish mackerel			181,760	7,488	477,328	26,886	659,088	34,374
Spot	400	8	8,481	130	2,470	38	32,451	825
Squeteague	49,400	1,492	725,600	21,452	17,813	534	898,563	26,967
Strawberry bass	42,100	1,210	15,000	300			221,606	5,166
Whiting	1,500	105	12,500	774	1,750	118	82,150	3,657
Yellow-tail			125	2	1,241	19	1,366	21
Alligator hides			22,126	3,063	78,561	10,475	[a] 100,687	13,538
Clam, hard							[b] 5,200	325
Crab, hard							[c] 6,066	152

[a] Represents 22,375 in number. [b] Represents 650 bushels. [c] Represents 18,198 in number.

Table, showing by counties and species, the yield of the fisheries of the eastern coast of Florida in 1902—Continued.

Species.	Volusia.		Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Oyster			35,140	$2,008	17,500	$1,750	[a] 2,163,483	$37,188
Otter skins			650	3,700	2,277	13,652	[b] 2,927	17,352
Periwinkle							5,400	120
Prawn							3,012,360	62,896
Shrimp							494	34
Terrapin			640	64			[c] 3,940	1,164
Turtle					10,825	766	12,200	787
Tortoise-shell					20	50	20	50
Total	1,224,810	$41,983	6,459,061	95,610	969,250	71,614	19,584,265	477,868

[a] Represents 309,069 bushels. [b] Represents 2,927 in number. [c] Represents 1,480 in number.

THE YIELD BY DIFFERENT FORMS OF APPARATUS.

In eastern Florida the gill net is the most efficient form of apparatus in use, over half of the total catch, including almost all of the pompano and turtle, and the greater part of the mullet, shad, squeteague, and sheepshead, being taken in this way. Seines rank second in apparatus for quantity and value of product, taking all of the alewives, bream, and strawberry bass, and the greater part of the black bass, cat-fish, and terrapin. A vessel purse-seine fishery for Spanish mackerel in Dade County was fairly successful. Previously this fishery was prosecuted entirely by vessels from De Soto County on the west coast. The cast-net fishery is quite important. These nets are used mainly where other forms of apparatus are forbidden, principally in St. John and Volusia counties, where the mullet is the leading species captured. They are employed quite extensively in Nassau and Duval counties also, in the prawn fishery, of which product they take more than half of the total catch. A primitive form of pound net was used on St. Johns River in 1902, where cat-fish was the leading species taken. One vessel from Nassau County engaged in the line fishery for groupers, red snappers, and sea bass. In the boat fishery with lines Spanish mackerel and squeteague were the principal species secured, most of the former being caught by Fort Pierce fishermen during the spring months. Owing to the scarcity of turtles no nets have been set especially for them during the last two years. Other forms of apparatus are tongs, rakes, and grabs for oysters and clams, spears for flounders, etc., guns for alligators, traps for otters, and shovels for periwinkles.

Table showing by counties the yield of the seine fisheries of the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		Putman.		Orange.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Alewives							371,697	$1,238		
Black bass			6,600	$297	66,850	$2,674	124,710	4,988		
Bream			41,200	1,030	117,300	2,533	231,814	4,636		
Cat-fish			162,000	3,240	74,600	1,602	184,542	2,768		
Channel bass	10,000	$300	14,800	592					2,960	$89
Croaker			200	5						
Drum	1,200	36	10,400	416					2,500	75
Flounders	2,000	60	1,850	55	950	24			700	21
Hickory shad					700	32	406	6		
Mullet	50,000	1,500	11,875	475			7,012	53	3,500	35
Pompano	500	50	260	26					100	11
Shad					50,225	3,588	154,790	5,475		
Spot			1,600	64						
Squeteague	5,000	200	10,750	430					1,100	44
Strawberry bass			10,400	260	39,700	1,108	114,406	2,288		
Whiting			40,000	1,600					3,100	125
Crab, hard			2,000	50					1,000	25
Prawn	1,123,500	23,406								
Shrimp	157	11								
Terrapin	3,300	1,100								
Turtles					1,375	21				
Total	1,195,657	26,663	313,935	8,540	351,700	11,582	1,189,377	21,452	14,960	425

Species.	Volusia.		Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Spanish mackerel					150,000	$10,500	150,000	$10,500
Shore fisheries:								
Alewives	34,000	$358					405,697	1,596
Black bass	56,000	2,240	12,000	$300			266,160	10,499
Bream	193,200	4,750	60,000	1,200			643,514	14,149
Cat-fish	110,000	2,400	20,000	800			551,142	10,810
Channel bass	1,200	24					28,960	1,005
Croaker							200	5
Drum	800	16					14,900	543
Flounders	1,200	32					6,700	192
Hickory shad	660	25					1,766	63
Mullet	5,000	50					77,387	2,113
Pompano							860	87
Sailor's choice	1,300	26					1,300	26
Shad	243,000	19,800					448,015	28,863
Spot	400	8					2,000	72
Squeteague	1,400	52					18,250	726
Strawberry bass	42,100	1,210	15,000	300			221,606	5,166
Whiting							43,100	1,725
Crab, hard							3,000	75
Prawn							1,123,500	23,406
Shrimp							157	11
Terrapin							3,300	1,100
Turtles							1,375	21
Total	690,260	30,991	107,000	2,600			3,862,889	102,253
Grand total	690,260	30,991	107,000	2,600	150,000	10,500	4,012,889	112,753

Table showing, by counties, the yield of the gill-net fisheries of eastern Florida in 1902.

Species.	Nassau.		Duval.		Putnam.		Orange.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Channel bass									3,333	$100
Drum									1,000	30
Flounders									300	10
Hickory shad			11,500	$346	44,600	$2,210				
Mullet			1,856,000	18,560					80,000	800
Pompano									150	15
Shad	365,500	$36,550	807,700	46,450	108,166	6,590	3,600	$132	4,200	300
Sheepshead									1,500	45
Squeteague			60,000	1,800					13,400	400
Whiting									500	20
Total	365,500	36,550	2,735,200	67,156	152,766	8,800	3,600	132	104,383	1,720

Species.	Volusia.		Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			3,650	$56	900	$15	4,550	$71
Blue-fish			18,950	674	59,800	2,836	78,750	3,510
Bonito			1,400	26	5,020	151	6,420	177
Channel bass			26,500	401	275	4	30,108	505
Crevalle			5,600	86			5,600	86
Drum			4,350	67			5,350	97
Flounders			4,080	65	1,600	24	5,980	99
Grunts			10,300	156	8,142	149	18,442	305
Groupers			5,300	80	3,360	58	8,660	138
Hickory shad	800	$32					56,900	2,588
King-fish					990	10	990	10
Mangrove snapper			4,213	65	3,830	59	8,043	124
Mullet			4,811,544	36,539	19,985	164	6,767,529	56,063
Mutton-fish			1,450	22	1,690	26	3,140	48
Permit			6,250	125	4,092	129	10,342	254
Pig-fish			1,800	28			1,800	28
Pompano			125,110	10,010	138,811	11,693	264,071	21,718
Sailor's choice			27,198	413	3,885	59	31,083	472
Sergeant-fish			2,443	38	385	5	2,828	43
Shad	82,250	5,875					1,371,416	95,897
Sheepshead			287,401	5,298	33,300	500	322,201	5,843
Spanish mackerel			21,760	1,088	252,728	12,656	274,488	13,744
Spot			8,481	130	2,470	38	10,951	168
Squeteague			627,600	18,602	17,813	534	718,813	21,336
Whiting			12,500	774	1,750	118	14,750	912
Yellow-tail			125	2	1,241	19	1,366	21
Turtle, green					10,300	724	10,300	724
Turtle, hawksbill					525	42	525	42
Tortoise-shell					20	50	20	50
Total	83,050	5,907	6,018,005	74,745	572,912	30,063	10,035,416	225,073

Table showing, by counties, the yield of the pound-net fisheries of the eastern coast of Florida in 1902.

Species.	Duval.		Species.	Duval.	
	Lbs.	Value.		Lbs.	Value.
Cat-fish	16,000	$320	Spot	410	$10
Channel bass	1,000	30	Squeteague	500	15
Croaker	560	11	Whiting	300	15
Sailor's choice	200	3			
Sheepshead	250	7	Total	19,220	411

Table showing, by counties, the yield of the cast-net fisheries of the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Channel bass					26,667	$800
Croaker					5,833	175
Mullet					140,000	1,400
Sailor's choice					11,000	330
Sea bass					2,000	60
Sheepshead					5,700	200
Spot					16,590	500
Squeteague					2,500	100
Whiting					2,500	100
Prawn	1,667,760	$34,745	211,200	$4,400	9,900	345
Shrimp	337	23				
Total	1,668,097	34,768	211,200	4,400	222,690	4,010

Species.	Volusia.		Brevard.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Channel bass					26,667	$800
Croaker					5,833	175
Mullet	342,000	$2,640	14,000	$131	496,000	4,171
Sailor's choice					11,000	330
Sea bass					2,000	60
Sheepshead					5,700	200
Spot					16,590	500
Squeteague					2,500	100
Whiting					2,500	100
Prawn					1,888,860	39,490
Shrimp					337	23
Total	342,000	2,640	14,000	131	2,457,987	45,949

Table showing, by counties, the yield of the line fisheries of the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		Putnam.		Orange.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Groupers	10,000	$150								
Red snapper	20,000	400								
Sea bass	15,000	750								
Total	45,000	1,300								
Shore fisheries:										
Black bass							48,150	$1,950		
Cat-fish			18,000	$360	6,000	$150	25,600	512		
Channel bass									23,400	$700
Flounders									700	21
Pompano									300	30
Sea bass									2,800	85
Sheepshead									10,000	300
Spot									2,500	75
Squeteague									12,500	500
Whiting									20,000	800
Crab, hard			2,400	60					666	17
Total			20,400	420	6,000	150	73,750	2,462	72,866	2,528
Grand total	45,000	1,300	20,400	420	6,000	150	73,750	2,462	72,866	2,528

Table showing, by counties, the yield of the line fisheries of the eastern coast of Florida in 1902—Continued.

Species.	Volusia.		Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Groupers							10,000	$150
Red snapper							20,000	400
Sea bass							15,000	750
Total							45,000	1,300
Shore fisheries:								
Barracuda					1,000	$50	1,000	50
Black bass							48,150	1,950
Blue-fish					750	38	750	38
Bonito					700	35	700	35
Cat-fish							49,600	1,022
Channel bass							23,400	700
Crevalle					300	9	300	9
Flounders							700	21
Groupers			2,700	41	5,550	157	8,250	198
Grunts					15,000	450	15,000	450
King-fish			800	8	30,000	300	30,800	308
Mutton-fish					1,600	48	1,600	48
Pompano							300	30
Porgy					5,300	159	5,300	159
Sea bass	10,000	$150					12,800	235
Sheepshead	50,000	750			13,200	198	73,200	1,248
Spanish mackerel			160,000	6,400	74,600	3,730	234,600	10,130
Spot							2,500	75
Squeteague	48,000	1,440	98,000	2,850			158,500	4,790
Whiting	1,500	105					21,500	905
Crab, hard							3,066	77
Total	109,500	2,445	261,500	9,299	148,000	5,174	692,016	22,478
Grand total	109,500	2,445	261,500	9,299	148,000	5,174	737,016	23,778

Table showing by counties the yield of the tong, rake, and grab fisheries of the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Oyster	25,669	$367				
Shore fisheries:						
Clam, hard					5,200	$325
Oyster	310,100	4,500	14,700	$700	701,400	12,630
Total	310,100	4,500	14,700	700	706,600	12,955
Grand total	335,769	4,867	14,700	700	706,600	12,955

Species.	Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Oyster					25,669	$367
Shore fisheries:						
Clam, hard					5,200	325
Oyster	35,140	$2,008	17,500	$1,750	1,078,840	21,588
Total	35,140	2,008	17,500	1,750	1,084,040	21,913
Grand total	35,140	2,008	17,500	1,750	1,109,709	22,280

Table showing by counties the yield by miscellaneous apparatus for the eastern coast of Florida in 1902.

Species.	Nassau.		Duval.		St. John.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Oyster	99,624	$1,423				
Shore fisheries:						
Channel bass					4,500	$135
Flounders					36,000	1,080
Sheepshead					2,900	102
Periwinkle			5,400	$120		
Oyster	959,350	13,810				
Total	959,350	13,810	5,400	120	43,400	1,317
Grand total	1,058,974	15,233	5,400	120	43,400	1,317

Species.	Brevard.		Dade.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Oyster					99,624	$1,423
Shore fisheries:						
Channel bass					4,500	135
Flounders					36,000	1,080
Sheepshead					2,900	102
Alligator hides	22,126	$3,063	78,561	$10,475	100,687	13,538
Otter skins	650	3,700	2,277	13,652	2,927	17,352
Periwinkle					5,400	120
Oyster					959,350	13,810
Terrapin	640	64			640	64
Total	23,416	6,827	80,838	24,127	1,112,404	46,201
Grand total	23,416	6,827	80,838	24,127	1,212,028	47,624

THE SHAD FISHERY.

The shad fishery shows a most gratifying increase over the canvass of 1897. In that year the yield was 1,011,180 pounds of shad, valued at $41,572, while in 1902 it was 1,819,431 pounds, valued at $124,760. Comparing the statistics for 1902 with those for 1890, when the catch was 2,654,022 pounds, worth $104,283, there has been a decrease of 834,591 pounds, but an increase of $20,477 in value. Both the St. Johns and St. Marys rivers, in which the shad are taken, show an increase. The following table gives, by counties, the number and value of shad secured in the fisheries of the eastern coast of Florida in 1902:

Table showing the number of shad taken in each county on the eastern coast of Florida in 1902.

Counties.	No.	Value.	Counties.	No.	Value.
Nassau	73,100	$36,550	St. John	1,200	$300
Duval	234,500	46,450	Volusia	104,500	25,675
Putnam	49,555	10,178			
Orange	46,936	5,607	Total	[a]509,791	124,760

[a] Represents 1,819,431 pounds.

WHOLESALE FISHERY TRADE.

Brevard County leads in every respect in the wholesale trade in fishery products. Indian River is almost wholly within the limits of this county and along its shores are many firms and individuals who furnish the fishermen the necessary netting to engage in the business and then reimburse themselves from the catch. In Duval, Putnam, Volusia, and Orange counties, which are on St. Johns River, the principal species handled by the wholesale firms are shad, black bass, bream, and mullet. All of the data shown in the following table, with the exception of the ice used and the wages paid, have been included in the regular tables relating to the amount of capital invested in the fisheries:

Table showing by counties the investment and number of persons employed in the wholesale fishery trade on the eastern coast of Florida in 1902.

Items.	Duval.		Putnam, St. Johns, and Volusia.[a]		Orange.		Brevard.		Dade.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	3	$14,200	3	$3,400	4	$2,600	25	$13,400	8	$8,250	43	$41,850
Cash capital	....	18,000	......	2,250	....	4,900	....	36,200	....	15,250	....	76,600
Ice used	....	7,600	......	1,250	....	1,472	....	40,250	....	13,190	....	63,762
Wages paid	....	9,640	......	5,470	....	1,130	....	15,550	....	5,680	....	37,470
Employees	25	....	15	....	11	....	90	....	35	....	176	....
Total	....	49,440	......	12,370	....	10,102	....	105,400	....	42,370	....	219,682

[a] One establishment in each county.

PREPARED PRODUCTS.

The only fishery products prepared in this region are oysters and prawn, the latter being locally known as shrimp. At one time the canning of oysters was an important business in Nassau County, where 4 factories were in operation in 1894, but in 1897, when this region was canvassed, there was but one factory in the county. In 1902 2 factories were operating, a part of the supply of one of these coming from Georgia waters. A factory was operated at St. Augustine also. In addition to canning oysters, one of the factories in Nassau County put up pickled prawn. In the preparation of this product the heads of the prawn are removed, the bodies boiled, and then put in pickle in 2, 3, 5, 8, and 15 gallon kegs. A 15-gallon keg, when filled, has a gross weight of about 125 pounds. The following table shows the extent of the preparation of fishery products on this coast.

Preparation of fishery products on the eastern coast of Florida in 1902.

Items.	Total. No.	Total. Value.	Items.	Total. No.	Total. Value.
Establishments	a 3	$17,450	Oysters canned—Continued.		
Cash capital		39,150	Two-pound cans, number	190,280	$19,356
Wages paid		14,730	Oyster shells sold..bushels	220,000	3,100
Employees	244		Prawn utilized..........do	1,773	2,216
Oysters utilized.....bushels	272,350	28,135	Prawn pickled.....gallons	21,300	10,650
Oysters canned:					
One-pound cans, number	1,116,000	58,950			

[a] Two of these establishments are located in Nassau County and one in St. Johns County.

STATISTICS OF THE FISHERIES OF THE GULF STATES, 1902.

PREPARED IN THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES, UNITED STATES FISH COMMISSION.

A. B. ALEXANDER,
Assistant in Charge.

STATISTICS OF THE FISHERIES OF THE GULF STATES, 1902.

The Gulf States, as here considered, comprise the western coast of Florida, Alabama, Mississippi, Louisiana, and Texas. The information presented applies only to the coast fisheries of commercial importance prosecuted in the Gulf of Mexico and bays and rivers immediately tributary, and does not include the fisheries of the interior waters of these states. The inquiries cover the calendar year 1902, and were begun in March and concluded in June, 1903. The results, which have already been published in condensed form as Statistical Bulletin No. 147, indicate that the fisheries of these states were more extensive in 1902 than in any previous year for which statistics are available.

The number of persons employed was 18,029, of whom 12,901 were engaged as fishermen in the vessel and shore fisheries, and 5,128 as shoresmen in wholesale fish establishments, oyster canneries, and other branches of industry connected with the fisheries. Florida employed in its fisheries 6,416 persons, Alabama 1,098, Mississippi 4,344, Louisiana 5,027, and Texas 1,144. The largest increase in the number of persons employed as compared with the returns for 1897, the year for which the last canvass was made, was 1,779, or 69.35 per cent, in Mississippi. There have also been comparatively large increases in all of the other states except Texas, where there was a slight decrease.

The total amount of capital invested in 1902 was $4,707,460, of which $1,945,320 was in Florida, $328,285 in Alabama, $1,270,408 in Mississippi, $789,723 in Louisiana, and $373,724 in Texas. There has been considerable increase in the investment in all of these states since 1897, and especially in Mississippi, where it amounted to $752,107, or 145.11 per cent; in Florida the increase was $796,058, or 69.26 per cent; and in Alabama $163,096, or 98.73 per cent.

The number of fishing and transporting vessels employed was 714, valued at $953,925. Their net tonnage was 9,221 tons, and the value of their outfit $341,920. The number of boats in the shore fisheries was 7,102, valued at $707,129. The fishing apparatus used on vessels and boats was valued at $198,414, the shore and accessory property at $1,586,672, and the cash capital amounted to $919,400.

The products of the fisheries in 1902 aggregated 113,696,970 pounds, valued at $3,494,196. Of this quantity the gulf coast of Florida produced 48,120,019 pounds, valued at $1,462,166; Alabama produced 9,351,447 pounds, valued at $266,682; Mississippi, 23,426,965 pounds,

valued at $553,220; Louisiana, 24,754,135 pounds, valued at $858,314; and Texas, 8,044,404 pounds, valued at $353,814. The more important species in the fisheries of these states are oysters, the yield of which was 34,115,935 pounds, or 4,873,705 bushels, valued at $1,263,689; mullet, including mullet roe, 27,233,322 pounds, $448,806; sponges, 346,889 pounds, $364,422; shrimp, 12,366,915 pounds, $198,979; trout or squeteague, 4,789,047 pounds, $173,207; buffalo-fish, 3,006,610 pounds, $26,556; cat-fish, 2,415,315 pounds, $72,991; channel bass or red-fish, 2,607,881 pounds, $82,622; Spanish mackerel, 1,583,891 pounds, $64,458; sheepshead, 1,974,815 pounds, $48,590, and crabs, 1,708,625 pounds, $29,741. A number of other species also were taken in considerable quantities.

Since 1897 the total yield of the fisheries has increased 48,336,347 pounds, or 73.95 per cent in quantity, and $1,222,470, or 53.81 per cent in value, divided among the different states in varying proportions, with by far the greater part in Mississippi, Alabama, and Florida. The most remarkable gain was in Mississippi, where the quantity of products increased 199.20 per cent and the value 187.68 per cent. All of the states showed an increased catch of the more important species since 1897, and in all the states except Texas, there was also a large increase in the catch of oysters.

The oyster fishery is extensive in all the states of this region, the yield being largest in Mississippi and Louisiana. Oysters have been cultivated to some extent in Alabama in recent years, and in 1902 the yield from planted areas was 53,844 bushels, having a value of $39,475, or more than 48 per cent of the value of the entire oyster output of the state. In the other states not much progress has so far been made in oyster planting, but in Mississippi and Louisiana laws have recently been enacted for the protection and improvement of the natural oyster grounds, and in the latter state efforts are being made to develop the use of unproductive areas for the purpose of oyster cultivation.

Some of the earlier publications relating to the fisheries of the Gulf States are as follows:

Fisheries of the Gulf of Mexico, by Silas Stearns. The Fisheries and Fishery Industries of the United States, Section II. Geographical Review of the Fisheries for 1880.

Report on the Fisheries of the Gulf States, by J. W. Collins and H. M. Smith. Bulletin U. S. Fish Commission 1891.

Report on the Coast Fisheries of Texas, by Charles H. Stevenson. Report U. S. Fish Commission 1889–1891.

The Fish and Fisheries of the Coastal Waters of Florida. Transmitted to the United States Senate by the Commissioner of Fish and Fisheries, January 28, 1897. Senate Document 100, Fifty-fourth Congress, second session. See also pages 263–342, Report of U. S. Fish Commissioner for 1896.

Statistics of the Fisheries of the Gulf States. Report U. S. Fish Commission, 1899.

The following tables give the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of the Gulf States in 1901; also a comparison of the extent of the fisheries in 1897 and 1902:

Table showing the number of persons engaged in the fisheries of the Gulf States in 1902.

States.	Fishermen.	Shoresmen.	Total.
Florida	5,579	837	6,416
Alabama	714	384	1,098
Mississippi	1,787	2,557	4,344
Louisiana	3,766	1,261	5,027
Texas	1,055	89	1,144
Total	12,901	5,128	18,029

Table showing the investment in the fisheries of the Gulf States in 1902.

Items.	Florida.		Alabama.		Mississippi.	
	No.	Value.	No.	Value.	No.	Value.
Vessels	306	$479,125	77	$96,450	192	$231,100
Tonnage	4,737		927		2,150	
Outfit		234,464		19,085		49,550
Boats	2,666	330,220	317	11,942	590	65,800
Seines	146	13,075	13	1,020	146	14,605
Gill nets	1,661	46,742	19	500	32	440
Stop nets	302	16,110				
Trammel nets	41	2,590	124	2,740	91	8,752
Fyke nets	10	60				
Dip nets	16	9				
Cast nets	77	362			27	134
Lines		2,472		810		827
Sponge apparatus		6,663				
Dredges			20	540	442	11,510
Tongs	608	4,887	449	2,617	659	2,627
Minor apparatus		2,486		6		56
Shore and accessory property		313,805		135,075		724,807
Cash capital		492,250		57,500		160,200
Total		1,945,320		328,285		1,270,408

Items.	Louisiana.		Texas.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels	77	$39,595	62	$107,655	714	$953,925
Tonnage	468		939		9,221	
Outfit		13,535		25,286		341,920
Boats	2,968	240,203	561	58,964	7,102	707,129
Seines	155	18,788	166	16,735	626	64,223
Gill nets					1,712	47,682
Stop nets					302	16,110
Trammel nets					256	14,082
Fyke nets	114	606			124	666
Dip nets			80	20	96	29
Cast nets			115	357	219	853
Lines		6,283		698		11,090
Sponge apparatus						6,663
Dredges					462	12,050
Tongs	1,848	9,218	297	1,680	3,861	21,029
Minor apparatus		610		779		3,937
Shore and accessory property		333,935		79,050		1,586,672
Cash capital		126,950		82,500		919,400
Total		789,723		373,724		4,707,460

Table showing the quantity and value of products taken in the fisheries of the Gulf States in 1902.

Species.	Florida.		Alabama.		Mississippi.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish	42,140	$1,051				
Angel-fishes	71,126	1,831	2,450	$77	2,450	$58
Barracuda	34,435	1,203				
Black bass	12,680	455	36,050	3,218	17,060	864
Blue-fish, fresh	346,606	10,567	21,025	705	11,695	316
Blue-fish, salted	3,000	120				
Bonito	10,100	503				
Buffalo-fish			108,100	2,251	4,650	66
Butter-fish	3,140	46				
Cat-fish	75,800	1,690	150,750	3,821	62,400	1,267
Channel bass, or red-fish	1,104,251	16,247	70,315	2,722	93,270	4,167
Crappie			11,450	757	1,750	82
Crevalle	54,665	643	5,375	73		
Croaker			57,900	1,157	273,000	8,573
Drum, fresh-water			2,050	96		
Drum, salt-water	193,625	2,738	4,910	92	11,660	318
Flounders	80,181	2,182	36,100	1,330	79,460	3,225
German carp	1,175	33				
Groupers	437,089	7,279	635,000	6,350		
Grunts	374,200	18,029				
Hog-fish	65,190	3,236				
Hound-fish	6,000	360				
Jew-fish			2,000	40		
Jurel	30,025	369	200	4		
King-fish	151,900	3,843	800	23		
Lady-fish, fresh	697,800	11,945	1,375	33		
Lady-fish, salted	700	21				
Margate-fish	3,500	222				
Menhaden	2,500	25	10,000	25		
Moon-fish	10,628	314	800	10		
Mullet, fresh	22,223,685	327,123	1,546,300	23,457	593,750	10,047
Mullet, salted	2,589,190	77,313			6,000	300
Mullet roe, salted	134,887	6,270				
Mutton-fish	28,301	849				
Permit	10,000	500				
Pig-fish	2,000	60	18,950	349		
Pike and pickerel	175	9	1,500	90		
Pompano	487,099	26,276	10,800	829	6,645	467
Porgy	70,960	3,548				
Pork-fish	23,332	3,145				
Sailor's choice, or pin-fish	111,746	3,736	12,500	209	6,600	166
Sardines	29,600	998				
Sea bass	9,800	128	3,850	151	3,445	178
Shad			150	3		
Sheepshead	1,373,650	21,686	75,050	2,820	70,225	2,964
Snapper, red	8,074,066	237,428	3,466,500	69,331		
Snappers, other	358,256	10,428	550	14		
Spanish mackerel, fresh	1,432,356	55,908	33,650	1,285	7,455	415
Spanish mackerel, salted	40,550	1,622				
Spot	14,250	300	63,850	1,035	77,500	2,021
Strawberry bass			14,950	1,007	1,750	82
Sturgeon	343,291	8,532	100,000	3,930	24,100	1,200
Caviar	5,691	3,026	5,000	2,000	414	310
Suckers	4,800	372				
Sun-fishes	15,100	646	17,200	1,118	3,850	124
Tang, or surgeon-fish	200	10				
Trout or squeteague, fresh	1,804,614	44,221	259,450	10,586	473,345	17,728
Trout or squeteague, salted	54,098	2,024				
Trunk-fish	300	12				
Turbot	850	66				
Warmouth			18,200	1,155	4,500	281
Whiting	20,254	303	24,900	482	53,310	1,252
Yellow-tail	93,687	6,036	325	6		
Other fish	400	16				
Alligator hides	54,400	4,109				
Clam	800	100				
Conch	3,334	890				
Crab, hard	1,333	83	75,230	2,218	234,933	4,680
Crab, soft	280	84			30,233	2,830
Crab, stone	11,681	1,799				
Crawfish	55,664	3,282				
Otter skins	356	1,015				
Oyster	4,057,107	124,108	2,432,222	119,773	16,835,924	426,222
Shrimp	17,280	288	200	12	4,423,900	58,398
Sponges	346,889	364,422				
Terrapin	30,899	4,227	6,470	1,913	11,691	4,619
Tortoise-shell	495	1,732				
Turtle	369,257	28,385	7,000	125		
Turtle eggs	600	99				
Total	48,120,019	1,462,166	9,351,447	266,682	23,426,965	553,220

Table showing the quantity and value of products taken in the fisheries of the Gulf States in 1902—Continued.

Species.	Louisiana.		Texas.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish					42,140	1,051
Angel-fishes					76,026	1,966
Barracuda					34,435	1,203
Black bass	18,940	1,328			84,730	5,865
Blue-fish, fresh	100	6	16,350	721	395,776	12,315
Blue-fish, salted					3,000	120
Bonito					10,100	503
Buffalo-fish	2,887,860	23,919	6,000	320	3,006,610	26,556
Butter-fish					3,140	46
Cat-fish	2,051,365	63,024	75,000	3,189	2,415,315	72,991
Channel bass, or red-fish	441,595	19,961	898,450	39,525	2,607,881	82,622
Crappie					13,200	839
Crevalle	3,160	113	6,680	192	69,880	1,021
Croaker	154,860	7,188	58,050	2,408	543,810	19,326
Drum, fresh-water	3,500	35			5,550	131
Drum, salt-water	51,280	1,302	157,400	3,188	418,875	7,638
Flounders	2,100	129	240,900	11,093	438,741	17,959
German carp					1,175	33
Groupers			40,169	1,195	1,112,258	14,824
Grunts					374,200	18,029
Hog-fish			4,900	204	70,090	3,440
Hound-fish					6,000	360
Jew-fish			65,722	2,137	67,722	2,177
Jurel					30,225	373
King-fish					152,700	3,866
Lady-fish, fresh					699,175	11,978
Lady-fish, salted					700	21
Margate-fish					3,500	222
Menhaden					12,500	50
Moon-fish					11,428	324
Mullet, fresh	122,710	3,884	16,800	412	24,503,245	364,923
Mullet, salted					2,595,190	77,613
Mullet roe, salted					134,887	6,270
Mutton-fish					28,301	849
Permit					10,000	500
Pig-fish					20,950	409
Pike and pickerel			57,300	2,239	58,975	2,338
Pompano	3,230	350	30,570	2,238	538,344	30,160
Porgy					70,960	3,548
Pork-fish					23,332	3,145
Sailor's choice, or pin-fish					130,846	4,111
Sardines					29,600	998
Sea bass					17,095	457
Shad					150	3
Sheepshead	338,560	11,381	217,330	9,739	1,974,815	48,590
Silver perch	62,850	3,009			62,850	3,009
Snapper, red			2,067,987	103,398	13,608,553	410,157
Snappers, other					358,806	10,442
Spanish mackerel, fresh	6,050	607	63,830	4,621	1,543,341	62,836
Spanish mackerel, salted					40,550	1,622
Spot					155,600	3,356
Strawberry bass					16,700	1,089
Sturgeon					467,391	13,662
Cavier					11,105	5,336
Suckers					4,800	372
Sun-fishes	7,900	246			44,050	2,134
Tang, or surgeon-fish					200	10
Trout or squeteague, fresh	1,078,240	49,071	1,119,300	49,577	4,734,949	171,183
Trout or squeteague, salted					54,098	2,024
Trunk-fish					300	12
Turbot					850	66
Warmouth					22,700	1,436
Whiting			41,700	1,596	140,164	3,633
Yellow-tail	6,120	245			100,132	6,287
Other fish	31,400	1,164	21,650	722	53,450	1,902
Alligator hides	194,840	23,132			249,240	27,241
Clam					800	100
Conch					3,334	890
Crab, hard	1,312,135	16,025	42,800	2,022	1,666,431	25,028
Crab, soft					30,513	2,914
Crab, stone					11,681	1,799
Crawfish	16,000	615			71,664	3,897
Otter skins					356	1,015
Oyster	8,388,891	493,227	2,401,791	100,359	34,115,935	1,263,689
Shrimp	7,634,720	131,715	290,815	8,566	12,366,915	198,979
Sponges					346,889	364,422
Terrapin	30,589	6,439	5,850	765	85,499	17,963
Tortoise shell					495	1,732
Turtle	5,140	199	97,060	3,388	478,457	32,097
Turtle eggs					600	99
Total	24,754,135	858,314	8,044,404	353,814	113,696,970	3,494,196

Supplementary table showing certain of the above products in number and bushels.

Products.	Florida.		Alabama.		Mississippi.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alligator hides ....number..	9,067	$4,109				
Clams ....bushels..	100	100				
Crab, hard ....number..	3,999	83	225,690	$2,218	704,799	$4,680
Crab, soft ....do....	840	84			90,699	2,830
Crab, stone ....do....	11,681	1,799				
Otter skins ....do....	201	1,015				
Oysters ....bushels..	579,587	124,108	347,460	119,773	2,405,132	426,222
Terrapin ....number..	10,593	4,227	3,597	1,913	8,496	4,619

Products.	Louisiana.		Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alligator hides ....number..	38,968	$23,132			48,035	$27,241
Clams ....bushels..					100	100
Crab, hard ....number..	3,936,405	16,025	128,400	$2,022	4,999,293	25,028
Crab, soft ....do....					91,539	2,914
Crab, stone ....do....					11,681	1,799
Otter skins ....do....					201	1,015
Oysters ....bushels..	1,198,413	493,227	343,113	100,359	4,873,705	1,263,689
Terrapin ....number..	15,294	6,439	2,925	765	40,905	17,963

Comparative table showing the extent of the fisheries of the Gulf States in 1897 and 1902.

States.	Persons engaged.				Capital invested.			
	1897.	1902.	Increase or decrease in 1902 compared with 1897.		1897.	1902.	Increase in 1902 compared with 1897.	
			No.	Percentage.			Amount.	Percentage.
Florida	5,011	6,416	+1,405	+28.03	$1,149,262	$1,945,320	$796,058	69.26
Alabama..........	789	1,098	+ 309	+39.16	165,189	328,285	163,096	98.73
Mississippi	2,565	4,344	+1,779	+69.35	518,301	1,270,408	752,107	145.11
Louisiana	4,403	5,027	+ 624	+14.17	513,813	789,723	275,910	53.69
Texas	1,199	1,144	− 55	− 4.58	237,496	373,724	136,228	57.36
Total......	13,967	18,029	+4,062	+29.08	2,584,061	4,707,460	2,123,399	82.17

States.	Products.							
	Pounds.				Value.			
	1897.	1902.	Increase in 1902 compared with 1897.		1897.	1902.	Increase in 1902 compared with 1897.	
			Amount.	Percentage.			Amount.	Percentage.
Florida	28,255,219	48,120,019	19,864,800	70.30	$944,793	$1,462,166	$517,373	54.76
Alabama..........	4,699,381	9,351,447	4,652,066	98.99	134,438	266,682	132,244	98.14
Mississippi	7,829,685	23,426,965	15,597,280	199.20	192,298	553,220	360,922	187.68
Louisiana	17,401,788	24,754,135	7,352,347	42.25	713,587	858,314	144,727	20.28
Texas	7,174,550	8,044,404	869,854	12.12	286,610	353,814	67,204	23.44
Total......	65,360,623	113,696,970	48,336,347	73.95	2,271,726	3,494,196	1,222,470	53.81

FISHERIES OF WESTERN FLORIDA.

The west side of Florida has a longer coast line than any other Gulf state, its length being about 2,810 miles. The shore line, like that of the eastern coast of the state, is low, and is indented with numerous bays, sounds, and lagoons, which furnish good harborage for the light-draft fishing vessels. The principal indentations are Perdido Bay, Pensacola Bay, Santa Rosa Sound, Choctawhatchee Bay, St. Andrews Bay, Apalachicola Bay, St. Georges Sound, Apalachee Bay, Wiccassassee Bay, Clearwater Bay, Tampa Bay, Sarasota Bay, and Charlotte Harbor. While the rivers and small streams entering the gulf are numerous, the principal ones being the Escambia, Choctawhatchee, Apalachicola, Suwanee, Withlacoochee, Manatee, and Caloosahatchee, but little fishing, other than for sturgeon, is prosecuted in any of them except the Apalachicola River.

A serious difficulty encountered in certain counties bordering on the gulf is the lack of shipping facilities. To counteract this as far as possible, the wholesale dealers at Cedar Key, St. Petersburg, Tampa, and Punta Gorda operate a large fleet of transporting vessels which make regular trips to the fishing camps, taking out supplies and bringing back the catch. Nearly all of these vessels are fitted with refrigerating compartments, in which the fish are stored and thus brought to market in excellent condition. Formerly the fish were placed loose in the hold of the vessel with cracked ice thrown over them, but the loss from spoiling, caused by delays incident to head winds and calms, was so great that the dealers were compelled to adopt the present method.

During 1903 the Manatee County region, which is one of the best fishing sections in the state, was penetrated by a railroad which has been constructed as far south as Sarasota, and is eventually to be extended to Boca Grande. The Boca Grande terminus will undoubtedly exert a considerable influence upon the fisheries. At the present time the fishermen from lower Manatee County and Lee County ship their fish to Punta Gorda, on Charlotte Harbor, where there is a railroad connecting with northern points. Punta Gorda is 30 miles from the mouth of the harbor, however, while Boca Grande is at the entrance, and with the dealers located at the latter place the vessels will be saved the long journey to Punta Gorda.

A large storage and fish-fertilizer plant has been erected at Punta Gorda, but was not finished in time to operate in 1902. It is the intention of the company operating this plant to freeze the better grades of gulf fish, and convert the nonedible and spoiled fish into fertilizer.

A fire at Cedar Key May 19, 1902, which burned down the railroad station and one of the wholesale establishments and damaged several

others, considerably curtailed the fish trade of that place for several months.

Shad have been reported a number of times from the west coast of Florida, and an occasional specimen has been found by scientists. A Pensacola fisherman, who claimed to have caught 12 or 15 shad in a seine the latter part of February, 1900, in the early part of 1903 shipped to the Bureau of Fisheries two specimens which proved to be the Alabama shad (*Alosa alabamæ*). It is possible that this species is more abundant than is generally supposed, as but little netting has been done in the rivers of this region until within the last two or three years.

The west coast of Florida leads all of the other Gulf States in the catch of blue-fish, mullet, pompano, red snapper, grouper, Spanish mackerel, turtle, and a number of less important species. The following tables present in condensed form the extent of the fisheries in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	1,906
On vessels transporting	146
In shore or boat fisheries	3,527
Shoresmen	837
Total	6,416

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	243	$396,175	Apparatus—shore fisheries:		
Tonnage	3,928		Trammel nets	41	$2,590
Outfit		190,611	Fyke nets	10	60
Vessels transporting	63	82,950	Dip nets	16	9
Tonnage	809		Cast nets	77	362
Outfit		43,853	Lines		540
Boats	2,666	330,220	Sponge apparatus		3,153
Apparatus—vessel fisheries:			Tongs, oyster	557	4,510
Seines	12	2,845	Tongs, terrapin	10	30
Gill nets	90	2,275	Traps, fish	244	520
Lines		1,932	Traps, otter	496	175
Sponge apparatus		3,510	Spears	58	33
Tongs	41	347	Guns	103	1,680
Spears	5	3	Minor apparatus		75
Apparatus—shore fisheries:			Shore and accessory property		313,805
Seines	134	10,230	Cash capital		492,250
Gill nets	1,571	44,467			
Stop nets	302	16,110	Total		1,945,320

Table of products.

Products.	Florida. Lbs.	Florida. Value.	Products.	Florida. Lbs.	Florida. Value.
Amber-fish	42,140	$1,051	Sea bass	9,800	$128
Angel-fish	71,126	1,831	Sheepshead	1,373,650	21,686
Barracuda	34,435	1,203	Snapper, red	8,074,066	237,428
Black bass	12,680	455	Snappers, other	358,256	10,428
Blue-fish, fresh	346,606	10,567	Spanish mackerel, fresh	1,432,356	55,908
Blue-fish, salted	3,000	120	Spanish mackerel, salted	40,550	1,622
Bonito	10,100	503	Spot	14,250	300
Butter-fish	3,140	46	Sturgeon	343,291	8,532
Cat-fish	75,800	1,690	Sturgeon, caviar	5,691	3,026
Channel bass or red-fish	1,104,251	16,247	Suckers	4,800	372
Crevalle	54,665	643	Sun-fish	15,100	646
Drum, salt-water	193,625	2,738	Tang	200	10
Flounders	80,181	2,182	Trout or squeteague, fresh	1,804,614	44,221
German carp	1,175	33	Trout or squeteague, salted	54,098	2,024
Groupers	437,089	7,279	Trunk-fish	300	12
Grunts	374,200	18,029	Turbot	850	66
Hog-fish	65,190	3,236	Whiting	20,254	303
Hound-fish	6,000	360	Yellow-tail	93,687	6,036
Jurel	30,025	369	Other fish	400	16
King-fish	151,900	3,813	Alligator hides	[a] 54,400	4,109
Lady-fish, fresh	697,800	11,945	Clam	[b] 800	100
Lady-fish, salted	700	21	Conch	[c] 3,334	890
Margate-fish	3,500	222	Crab, hard	[d] 1,333	83
Menhaden	2,500	25	Crab, soft	[e] 280	84
Moon-fish	10,628	314	Crab, stone	[f] 11,681	1,799
Mullet, fresh	22,223,685	327,123	Crawfish	55,664	3,282
Mullet, salted	2,589,190	77,313	Otter skins	[g] 356	1,015
Mullet roe, salted	134,887	6,270	Oyster	[h] 4,057,107	124,108
Mutton-fish	28,301	849	Shrimp	17,280	288
Permit	10,000	500	Sponges	346,889	364,422
Pig-fish	2,000	60	Terrapin	[i] 30,899	4,227
Pike and pickerel	175	9	Tortoise-shell	495	1,732
Pompano	487,099	26,276	Turtle	369,257	28,385
Porgy	70,960	3,548	Turtle eggs	600	99
Pork-fish	23,332	3,145			
Sailor's choice or pin-fish	111,746	3,736	Total	48,120,019	1,462,166
Sardines	29,600	998			

[a] Represents 9,067 in number.
[b] Represents 100 bushels.
[c] Includes 30 pearls, valued at $523.
[d] Represensl 3,999 in number.
[e] Represents 840 in number.
[f] Represents 11,681 in number.
[g] Represents 201 in number.
[h] Represents 579,587 bushels.
[i] Represents 10,593 in number.

THE FISHERIES BY COUNTIES.

Commercial fishing was carried on in 18 of the 19 coastal counties. Monroe, Escambia, and Hillsboro counties have the most important fishing interests, Monroe leading in nearly every particular, owing largely to its extensive vessel and shore fisheries for sponges and turtles. Hillsboro occupies second place in most respects, and carries on important red-snapper, mullet, and sponge fisheries. Nearly every county shows a substantial increase over the reports of the previous canvass, and the total increase is very large. In 1890 the catch amounted to 27,418,562 pounds, valued at $1,064,139; in 1895 to 31,929,127 pounds, worth $1,111,086; while in 1902 it was 48,120,019 pounds, valued at $1,462,166, a gain of 20,701,457 pounds and $398,027 over 1890, and of 16,190,892 pounds and $351,080 over 1895.

The following tables show the extent of the fishing industry by counties:

Table showing, by counties, the number of persons employed in the fisheries of the west coast of Florida in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Calhoun			17	1	18
Citrus	2		67	10	79
De Soto	30	62	152	63	307
Escambia	304		185	49	538
Franklin	94		623	347	1,064
Hernando			8	2	10
Hillsboro	140	48	395	131	714
Lafayette			16	6	22
Lee			234	29	263
Levy	7	8	261	61	337
Manatee		4	177	30	211
Monroe	1,279	12	891	83	2,265
Pasco	27	6	12	3	48
Santa Rosa	17	2	41		60
Taylor		2	36		38
Wakulla		2	173		175
Walton			17		17
Washington	6		222	22	250
Total	1,906	146	3,527	837	6,416

Table showing, by counties, the apparatus and capital employed in the fisheries of the west coast of Florida in 1902.

Items.	Calhoun.		Citrus.		De Soto.		Escambia.		Franklin.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			1	$250	3	$6,200	42	$144,100	18	$10,800
Tonnage			5		24		1,598		137	
Outfit				195		2,787		49,563		5,215
Vessels transporting					31	21,500				
Tonnage					269					
Outfit						23,840				
Boats	11	$1,080	65	1,535	95	7,755	108	14,830	433	44,030
Apparatus—vessel fisheries:										
Seines					4	2,200	2	120	3	265
Gill nets									3	90
Lines								1,686		16
Sponge apparatus										161
Tongs			2	18					31	262
Apparatus—shore fisheries:										
Seines	4	225					13	975	29	1,930
Gill nets	6	150	43	985	62	1,630	44	1,115	117	2,431
Stop nets					91	6,110				
Trammel nets							38	1,870		
Fyke nets							10	60		
Dip nets					1	1	15	8		
Cast nets							5	20	57	273
Lines				10				106		115
Sponge apparatus										90
Tongs, oyster			19	170	17	128	45	338	246	2,042
Tongs, terrapin									10	30
Traps, fish									200	300
Traps, otter			30	11	145	51				
Guns			2	30	10	150			35	525
Minor apparatus										25
Shore and accessory property		580		2,120		6,260		80,378		43,580
Cash capital				3,000		41,250				43,000
Total		2,035		8,324		119,862		295,169		155,180

Table showing, by counties, the apparatus and capital employed in the fisheries of the west coast of Florida in 1902—Continued.

Items.	Hernando.		Hillsboro.		Lafayette.		Lee.		Levy.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			19	$24,850					1	$750
Tonnage			240						8	
Outfit				13,455						350
Vessels transporting			17	39,700					5	2,350
Tonnage			258						46	
Outfit				15,180						655
Boats	8	$320	340	37,385	16	$480	112	$12,730	260	10,005
Apparatus—vessel fisheries:										
Lines				130						
Sponge apparatus				262						17
Tongs			6	50						
Apparatus—shore fisheries:										
Seines			13	1,200						
Gill nets	8	320	184	5,485	16	640	250	6,710	232	8,416
Stop nets	3	105	81	1,980			61	4,085	3	105
Trammel nets			3	150						
Cast nets			10	40						
Lines				13						15
Sponge apparatus				333						
Tongs, oyster			72	550					26	234
Traps, otter							250	88	71	25
Guns							27	540	6	90
Minor apparatus				2						2
Shore and accessory property		300		49,725		900		2,780		7,915
Cash capital				232,500						20,000
Total		1,045		422,990		2,020		26,933		50,929

Items.	Manatee.		Monroe.		Pasco.		Santa Rosa.		Taylor.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			152	$203,325	3	$2,000	4	$2,600		
Tonnage			1,844		24		33			
Outfit				114,235		1,675		2,586		
Vessels transporting	2	$1,200	2	14,500	3	1,450	1	1,200	1	$500
Tonnage	17		159		27		20		7	
Outfit		740		2,550		508		135		145
Boats	164	9,500	710	172,000	12	600	29	3,660	36	1,085
Apparatus—vessel fisheries:										
Seines							2	200		
Gill nets			86	2,150						
Lines				40				60		
Sponge apparatus				3,002		68				
Spears			5	3						
Apparatus—shore fisheries:										
Seines	11	2,220	10	465			3	240		
Gill nets	384	10,695	35	845	12	460			38	1,520
Stop nets	61	3,660			2	65				
Trammel nets							4	200		
Cast nets			5	29						
Lines				281						
Sponge apparatus				2,730						
Tongs, oyster							48	360		
Traps, fish			44	220						
Spears			58	29						
Minor apparatus				46						
Shore and accessory property		10,150		102,187		660		355		1,050
Cash capital				152,500						
Total		38,165		771,137		7,486		11,596		4,300

Table showing, by counties, the apparatus and capital employed in the fisheries of the west coast of Florida in 1902—Continued.

Items.	Wakulla.		Walton.		Washington.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing					2	$1,300	243	$396,175
Tonnage					15		3,928	
Outfit						550		190,611
Vessels transporting	1	$550					63	82,950
Tonnage	6						809	
Outfit		100						43,853
Boats	134	3,875	7	$1,175	126	8,175	2,666	330,220
Apparatus—vessel fisheries:								
Seines					1	60	12	2,845
Gill nets					1	35	90	2,275
Lines								1,932
Sponge apparatus								3,510
Tongs					2	17	41	347
Spears							5	3
Apparatus—shore fisheries:								
Seines	4	480	3	240	44	2,255	134	10,230
Gill nets	112	2,390			28	675	1,571	44,467
Stop nets							302	16,110
Trammel nets			6	370			41	2,590
Fyke nets							10	60
Dip nets							16	9
Cast nets							77	362
Lines								540
Sponge apparatus								3,153
Tongs, oyster	20	160			64	528	557	4,510
Tongs, terrapin							10	30
Traps, fish							244	520
Traps, otter							496	175
Spears	7	4					58	33
Guns					23	345	103	1,680
Minor apparatus								75
Shore and accessory property		645		75		4,145		313,805
Cash capital								492,250
Total		8,204		1,860		18,085		1,945,320

Table showing, by counties and species, the yield of the fisheries of the west coast of Florida in 1902.

Species.	Calhoun.		Citrus.		De Soto.		Escambia.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			800	$16	3,700	$47	4,540	$91
Black bass			7,250	184			1,200	60
Blue-fish, fresh	8,200	$246			5,000	100	127,193	4,384
Cat-fish							4,800	240
Channel bass	300	6	68,100	1,305	127,329	1,617	10,366	431
Crevalle			900	15			25,000	255
Drum			21,950	424	14,100	177		
Flounders	1,200	24					3,097	101
Groupers							230,914	2,499
Jurel							19,490	198
Lady-fish, fresh	60,000	900					12,000	140
Menhaden							1,500	15
Moon-fish							4,658	144
Mullet, fresh	77,500	3,150	1,015,000	17,398	1,550,220	15,503	41,020	1,127
Mullet, salted	182,600	5.480	27,000	540				
Mullet roe, salted	4,000	160	700	28				
Pig-fish							1,500	45
Pompano	5,541	277	400	32	15,000	600	5,858	316
Sailor's choice					3,000	40		
Sardines							800	8
Sheepshead	4,200	126	129,800	2,659	159,138	1,989	2,162	81
Snapper, red							7,091,715	209,654
Snappers, other			113,909	2,209	18,000	225	450	14
Spanish mackerel, fresh	52,780	2,111	1,000	60	624,400	21,974	161,853	5,099
Spot							12,600	255
Sturgeon							259,171	4,326
Caviar							3,491	1,753
Sun-fish			4,600	92	800	12	2,100	105
Trout or squeteague, fresh	33,700	1,011	157,944	3,092	125,787	2,516	25,778	1,061
Trout or squeteague, salted	2,660	80						
Whiting					3,000	40		
Yellowtail					657	8	4,300	129

Table showing, by counties and species, the yield of the fisheries of the west coast of Florida in 1902—Continued.

Species.	Calhoun.		Citrus.		De Soto.		Escambia.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alligator hides			400	$27	3,600	$210		
Crab, blue, hard							1,333	$83
Crab, blue, soft							280	84
Otter skins			16	90	100	250		
Oyster			69,396	2,311	90,650	4,887	70,000	6,000
Terrapin					9,000	1,200		
Turtle							80	2
Total	432,681	$13,571	1,619,165	30,482	2,753,481	51,425	8,129,249	238,700

Species.	Franklin.		Hernando.		Hillsboro.		Lafayette.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish	100	$2	110	$2				
Angel-fish	375	10			4,710	$72		
Black bass	2,000	100						
Blue-fish, fresh	8,190	169	100	2	10,300	259		
Bonito	200	8						
Butter-fish	300	3			2,840	43		
Cat-fish	65,000	1,300						
Channel bass	116,034	2,278	16,000	240	105,411	1,599		
Crevalle	150	3	500	8	880	14		
Drum	925	10	3,700	55	10,850	164		
Flounders	54,300	1,604			3,234	79		
German carp	1,175	33						
Groupers	2,500	50			61,600	671		
Grunts					17,300	254		
Jurel	50	1						
King-fish	200	10			2,700	108		
Mullet, fresh	1,169,800	15,781	168,100	3,362	2,329,888	22,516	640,000	$12,800
Mullet, salted	557,170	17,936	48,000	960	171,487	4,384	140,000	4,200
Mullet roe, salted	17,050	804	5,000	250	7,250	278	13,800	690
Pompano	8,360	413			61,923	3,570		
Sailor's choice					200	3		
Sea bass					3,800	38		
Sheepshead	14,200	418	4,200	126	128,310	1,926		
Snapper, red	4,000	200			850,600	23,975		
Snappers, other			7,000	140	17,420	262		
Spanish mackerel, fresh	25,180	1,060			61,674	3,113		
Spanish mackerel, salted	10,050	402						
Sturgeon	74,120	3,706						
Caviar	1,950	1,073						
Suckers	300	12						
Sun-fish	2,950	118						
Trout or squeteague, fresh	163,593	4,679	12,000	240	176,897	4,443		
Trout or squeteague, salted	22,038	768						
Whiting	200	2			1,380	21		
Other fish	250	10						
Alligator hides	7,500	875						
Crab, stone					800	40		
Oyster	2,749,810	75,297			137,270	8,112		
Shrimp	17,280	288						
Sponges:								
Grass	5,304	1,114			45,593	9,574		
Sheepswool	2,920	7,882			17,017	45,947		
Yellow	1,939	1,067			4,608	2,534		
Terrapin	3,200	264			2,400	200		
Turtle	800	56						
Total	5,111,463	139,806	264,710	5,385	4,238,342	134,199	793,800	17,690

Table showing, by counties and species, the yield of the fisheries of the west coast of Florida in 1902—Continued.

Species.	Lee.		Levy.		Manatee.		Monroe.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish							41,500	$1,038
Angel-fish	7,800	$98	4,000	$60	19,441	$242	22,650	1,133
Barracuda							34,435	1,203
Blue-fish, fresh	7,100	142	25,900	1,166	20,400	408	9,600	480
Bonito							9,900	495
Cat-fish			6,000	150				
Channel bass	163,000	2,038	88,667	1,333	369,444	4,619		
Crevalle			13,300	201			4,550	46
Drum	18,800	235	49,100	737	71,200	891		
Flounders					1,100	22		
Groupers			500	8			130,050	3,936
Grunts			2,000	30			354,900	17,745
Hog-fish							65,190	3,236
Hound-fish							6,000	360
Jurel							1,785	74
King-fish							149,000	3,725
Lady-fish, fresh							110,500	4,205
Margate-fish							3,500	222
Moon-fish							2,000	80
Mullet, fresh	3,859,101	38,591	4,309,448	86,189	3,106,410	31,064	110,000	3,300
Mullet, salted	72,000	1,050	25,000	750	375,369	5,005		
Mullet roe, salted	4,500	270	1,200	60	33,972	1,358		
Mutton-fish							28,301	849
Permit							10,000	500
Pompano	137,176	5,487	2,174	174	225,950	13,557	6,200	930
Porgy							70,960	3,548
Pork-fish							23,332	3,145
Sailor's choice	5,000	63			1,171	15	102,375	3,615
Sardines							27,800	980
Sea bass			6,000	90				
Sheepshead	399,981	5,000	95,219	2,857	379,210	4,866	150	8
Snapper, red							6,200	155
Snappers, others	12,000	150	60,433	1,432	27,700	346	90,534	5,432
Spanish mackerel, fresh	48,706	2,435	10,126	608	147,460	7,373	33,165	1,659
Spot							150	15
Sturgeon			10,000	500				
Caviar			250	200				
Suckers							4,500	360
Sun-fish							3,700	271
Tang							200	10
Trout or squeteague, fresh	298,970	5,979	103,141	2,779	476,175	11,904	650	33
Trunk-fish							300	12
Turbot							850	66
Whiting	4,000	50	200	3	10,974	137	500	50
Yellow-tail	1,200	15			3,200	41	82,830	5,798
Other fish							150	6
Alligator hides	30,600	2,040	6,900	450				
Clam			240	30			560	70
Conch							3,334	890
Crab, stone							10,881	1,759
Crawfish							55,664	3,282
Otter skins	210	525	30	150				
Oyster			729,841	17,377				
Sponges:								
Boat							2,455	1,473
Glove							7,365	1,111
Grass							88,242	18,753
Sheepswool			242	653			112,675	241,450
Velvet							5,852	3,187
Yellow			15	8			50,022	27,414
Wire, etc							230	46
Terrapin			10,800	1,800	2,700	226	2,259	532
Tortoise-shell							495	1,732
Turtle			29,908	2,800			338,069	25,511
Turtle eggs							600	99
Total	5,070,144	64,168	5,590,634	122,595	5,271,876	82,074	2,227,110	396,029

Table showing, by counties and species, the yield of the fisheries of the west coast of Florida in 1902—Continued.

Species.	Pasco.		Santa Rosa.		Taylor.		Wakulla.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish	280	$6	150	$3				
Black bass			1,130	56				
Blue-fish, fresh	6,900	267	11,873	263				
Channel bass	13,500	203	2,200	84			16,300	$326
Crevalle	1,185	19	1,700	17				
Drum	3,000	45						
Flounders			200	6			7,150	143
Groupers			11,525	115				
Lady-fish, fresh			20,000	250				
Lady-fish, salted			700	21				
Moon-fish			370	10				
Mullet, fresh	818,528	15,971	20,878	692	1,503,100	$30,062	895,625	17,913
Mullet, salted					221,000	6,630		
Mullet roe, salted					18,800	940		
Pike			175	9				
Pompano	410	23	606	22				
Sheepshead	11,700	341	980	37	8,000	160		
Snapper, red			121,551	3,441				
Snappers, other	10,600	212						
Spanish mackerel, fresh	4,890	294	4,692	169			2,685	54
Spot			700	14				
Sun-fish			500	25				
Trout or squeteague, fresh	38,000	760	5,834	267	5,000	100	15,200	304
Yellow-tail			100	3				
Oyster			64,400	5,520			56,000	2,000
Sponges:								
Grass	1,543	324						
Sheepswool	664	1,795						
Yellow	203	90						
Terrapin			540	5				
Total	911,403	20,350	270,804	11,032	1,755,900	37,892	992,960	20,740

Species.	Walton.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish					42,140	$1,051
Angel-fish	500	$10	2,610	$52	71,126	1,831
Barracuda					34,435	1,203
Black bass	1,100	55			12,680	455
Blue-fish, fresh	37,000	615	68,850	2,066	346,606	10,567
Blue-fish, salted			3,000	120	3,000	120
Bonito					10,100	503
Butter-fish					3,140	46
Cat-fish					75,800	1,690
Channel bass	1,600	48	6,000	120	1,104,251	16,247
Crevalle	6,500	65			54,665	643
Drum					193,625	2,738
Flounders	500	15	9,400	188	80,181	2,182
German carp					1,175	33
Groupers					437,089	7,279
Grunts					374,200	18,029
Hog-fish					65,190	3,236
Hound-fish					6,000	360
Jurel	8,200	86	500	10	30,025	369
King-fish					151,900	3,843
Lady-fish, fresh			495,300	6,450	697,800	11,945
Lady-fish, salted					700	21
Margate-fish					3,500	222
Menhaden	1,000	10			2,500	25
Moon-fish	800	24	2,800	56	10,628	314
Mullett, fresh	16,600	540	592,467	11,164	22,223,685	327,123
Mullett, salted			769,564	30,378	2,589,190	77,313
Mullett roe, salted			28,615	1,432	134,887	6,270
Mutton-fish					28,301	849
Permit					10,000	500
Pig-fish	500	15			2,000	60
Pike					175	9
Pompano	600	30	16,901	845	487,099	26,276
Porgy					70,960	3,548
Pork-fish					23,332	3,145
Sailor's choice					111,746	3,736
Sardines	1,000	10			29,600	998
Sea bass					9,800	128
Sheepshead	600	18	35,800	1,074	1,373,650	21,686
Snapper, red					8,074,066	237,428
Snappers, others	210	6			358,256	10,428

Table showing, by counties and species, the yield of the fisheries of the west coast of Florida in 1902—Continued.

Species.	Walton.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Spanish mackerel, fresh	30,600	$918	223,145	$8,981	1,432,356	$55,908
Spanish mackerel, salted			30,500	1,220	40,550	1,622
Spot	800	16			14,250	300
Sturgeon					343,291	8,532
Caviar					5,691	3,026
Suckers					4,800	372
Sun-fish	450	23			15,100	646
Tang					200	10
Trout or squeteague, fresh	5,600	243	160,345	4,810	1,804,614	44,221
Trout or squeteague, salted			29,400	1,176	54,098	2,024
Trunk-fish					300	12
Turbot					850	66
Whiting					20,254	303
Yellow-tail	1,400	42			93,687	6,036
Other fish					400	16
Alligator hides			5,400	477	54,400	4,109
Clam					800	100
Conch					3,334	890
Crab, blue, hard					1,333	83
Crab, blue, soft					280	84
Crab, stone					11,681	1,799
Crawfish					55,664	3,282
Otter skins					356	1,015
Oyster			89,740	2,604	4,057,107	124,108
Shrimp					17,280	288
Sponges:						
Boat					2,455	1,473
Glove					7,365	1,111
Grass					140,682	29,765
Sheepswool					133,518	297,727
Velvet					5,852	3,187
Yellow					56,787	31,113
Wire, etc					230	46
Terrapin					30,899	4,227
Tortoise-shell					495	1,732
Turtle	400	16			369,257	28,385
Turtle eggs					600	99
Total	115,960	2,805	2,570,337	73,223	48,120,019	1,462,166

FISHERIES BY APPARATUS.

Vessel fisheries.—Ten counties participated in the vessel fisheries, the products being secured with purse and haul seines, gill nets (principally for turtles), lines, spears, sponge apparatus, and oyster tongs. More than four-fifths of the total catch was made with lines, and of this 7,969,936 pounds, valued at $234,266, consisted of red snappers. Groupers and king-fish were the other principal species. In the seine catch Spanish mackerel occupy first place, and most of these were taken with purse seines in Hawks Channel, on the east coast, during January and February. Most of the gill nets were employed in the turtle fishery of Monroe County. Many of the vessels operating from here visit the coasts of Yucatan, Mexico, and Honduras, and engage in the fishery there. The sponge fishery is prosecuted from Franklin, Hillsboro, Levy, Monroe, and Pasco counties, with Monroe far in the lead. The tong fishery for oysters is most important in Franklin County, but is also prosecuted from Citrus, Hillsboro, and Washington counties. It shows a very considerable decrease, however. Spearing was practiced in but one county, Monroe, and was insignificant.

Shore fisheries.—The gill net is by far the most important form of apparatus in use in the shore fisheries, and the mullet is the principal species thus sought. Of the 22,896,192 pounds, valued at $426,370, taken in gill nets, 18,979,124 pounds, worth $322,522, consisted of mullet. The sea trout occupied second place in quantity and was third in value; the pompano was second in value. Other leading species were sheepshead, channel bass, Spanish mackerel, and sturgeon.

The seine catch has fallen off somewhat in recent years owing to the more general use of gill nets and stop nets. A number of seines are used in connection with the latter fishery, but as they are secondary in importance their value and catch have been shown with the stop nets. The mullet is again the leading species, although not to the same extent as in the gill-net fisheries. Other important species were Spanish mackerel, sea trout, lady-fish, and blue-fish.

While the stop-net fisheries ranked third in quantity of products secured, the tong fisheries exceeded them in the value of the catch. Mullet, sheepshead, sea trout, and channel bass were the principal species taken in the stop-net fishery.

The line fisheries have declined considerably in recent years, the fishermen devoting more of their time to fishing with other forms of apparatus. There is still an important line fishery in Monroe County, because of the difficulty of operating nets around Key West, where they are torn on the coral growths.

Trammel-net fishing was prosecuted from Escambia, Hillsboro, Santa Rosa, and Walton counties. In 1897, at the time of the last canvass, trammel nets were not used.

The cast-net and trap-net fisheries were not of much importance, the former being carried on from Escambia, Franklin, Hillsboro, and Monroe counties, and the latter from Franklin and Monroe counties. In the last-named county traps are a rather important form of apparatus.

Sponging was carried on from Franklin, Hillsboro, and Monroe counties, the last-named far outstripping the others.

A number of minor forms of apparatus were also used, the more important being guns, traps, dip nets, and fyke nets.

Table showing, by counties and apparatus, the yield of the vessel fisheries of the west coast of Florida.

Apparatus and species.	Citrus.		De Soto.		Escambia.		Franklin.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Blue-fish					293	$6		
Channel bass					19	1	83,300	$1,666
Mullet					5,920	55	30,600	522
Pompano					748	47	2,400	112
Sheepshead					305	24	6,000	225
Spanish mackerel			616,400	$21,574	37,328	1,412	6,000	290
Trout, or squeteague					15,228	533	81,543	2,447
Total			616,400	21,574	59,841	2,078	209,843	5,262

Table showing, by counties and apparatus, the yield of the vessel fisheries of the west coast of Florida—Continued.

Apparatus and species.	Citrus.		De Soto.		Escambia.		Franklin.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Mullet, salted							30,590	$920
Mullet roe, salted							1,250	50
Trout, or squeteague							1,400	42
Total							33,240	1,012
Lines:								
Amber-fish							100	2
Bonito							200	8
Groupers					222,869	$2,419	2,500	50
King-fish							200	10
Snapper, red					6,999,885	206,921	4,000	200
Total					7,222,754	209,340	7,000	270
Sponge apparatus:								
Grass sponge							2,595	545
Sheep's-wool sponge							2,126	5,738
Yellow sponge							854	470
Total							5,575	6,753
Tongs:								
Oyster	4,800	$150					251,650	6,709
Grand total	4,800	150	616,400	$21,574	7,282,595	211,418	507,308	20,006

Apparatus and species.	Hillsboro.		Levy.		Monroe.		Pasco.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Tortoise shell					60	$210		
Turtle					212,876	16,442		
Turtle eggs					200	33		
Total					213,136	16,685		
Lines:								
Amber-fish					5,900	148		
Barracuda					700	25		
Blue-fish					200	10		
Bonito					1,800	90		
Crevalle					50	1		
Groupers	48,400	$502			3,600	108		
Grunts					8,000	400		
Hog-fish					1,900	95		
King-fish					27,000	675		
Mutton-fish					800	24		
Permit					100	5		
Pompano					200	30		
Porgy					1,700	85		
Pork-fish					390	31		
Snapper, red	842,500	23,651			2,000	50		
Snappers, other					1,500	90		
Spanish mackerel					5,250	263		
Yellow-tail					4,000	280		
Total	890,900	24,153			65,090	2,410		
Spears:								
Angel-fish					400	20		
Barracuda					600	18		
Crawfish					600	34		
Total					1,600	72		
Sponge apparatus:								
Glove sponge					1,473	222		
Grass sponge	11,517	2,418			59,021	12,568	1,543	$324
Sheep's-wool sponge	7,069	19,087	242	$653	65,262	151,203	664	1,795
Velvet sponge					5,852	3,187		
Yellow sponge	1,552	853	15	8	24,445	13,404	203	90
Total	20,138	22,358	257	661	156,053	180,584	2,410	2,209
Tongs:								
Oyster	14,420	832						
Grand total	925,458	47,343	257	661	435,879	199,751	2,410	2,209

Table showing, by counties and apparatus, the yield of the vessel fisheries of the west coast of Florida—Continued.

Apparatus and species.	Santa Rosa.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Angel-fish			210	$4	210	$4
Black bass	30	$1			30	1
Blue-fish	873	43	3,750	113	4,916	162
Channel bass	1,200	36			84,519	1,703
Flounders			500	10	500	10
Lady-fish, fresh	10,000	100	12,500	188	22,500	288
Lady-fish, salted	700	21			700	21
Moon-fish	100	2	300	6	400	8
Mullet	7,978	224	3,600	72	48,098	873
Pompano	506	16	1,000	50	4,654	225
Sheepshead	800	32	2,700	81	9,805	362
Spanish mackerel	4,692	169	10,100	404	674,520	23,849
Trout, or squeteague	2,334	92	5,245	157	104,350	3,229
Total	29,213	736	39,905	1,085	955,202	30,735
Gill nets:						
Mullet, fresh			4,100	82	4,100	82
Mullet, salted			12,000	360	42,590	1,280
Mullet roe, salted			300	15	1,550	65
Tortoise shell					60	210
Turtle					212,876	16,442
Turtle eggs					200	33
Trout, or squeteague			1,700	51	3,100	93
Total			18,100	508	264,476	18,205
Lines:						
Amber-fish					6,000	150
Barracuda					700	25
Blue-fish					200	10
Bonito					2,000	98
Crevalle					50	1
Groupers	11,525	115			288,894	3,194
Grunts					8,000	400
Hog-fish					1,900	95
King-fish					27,200	685
Mutton-fish					800	24
Permit					100	5
Pompano					200	30
Porgy					1,700	85
Pork-fish					390	31
Snapper, red	121,551	3,444			7,969,936	234,266
Snappers, other					1,500	90
Spanish mackerel					5,250	263
Yellow-tail					4,000	280
Total	133,076	3,559			8,318,820	239,732
Spears:						
Angel-fish					400	20
Barracuda					600	18
Crawfish					600	34
Total					1,600	72
Sponge apparatus:						
Glove sponge					1,473	222
Grass sponge					74,676	15,855
Sheeps-wool sponge					75,363	178,476
Velvet sponge					5,852	3,187
Yellow sponge					27,069	14,825
Total					184,433	212,565
Tongs:						
Oyster			12,250	350	283,120	8,041
Grand total	162,289	4,295	70,255	1,943	10,007,651	509,350

Table showing the yield of the shore seine fisheries of the west coast of Florida in 1902.

Species.	Calhoun.		Escambia.		Franklin.		Hillsboro.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			3,090	$62	375	$10	900	$14
Blue-fish, fresh	8,200	$246	114,500	4,170	8,190	169	5,100	128
Butter-fish					300	3	734	11
Channel bass	300	6	6,042	252	28,234	522	11,439	172
Crevalle			20,000	200	150	3	300	5
Drum					925	10	1,590	24
Flounders	1,200	24	2,170	73	4,300	104	1,320	34
German carp					675	13		
Jurel			16,000	160	50	1		
Lady-fish	60,000	900	12,000	140				
Menhaden			1,500	15				
Moon-fish			4,275	132				
Mullet, fresh	23,500	2,340	18,300	570	351,500	4,718	375,808	3,370
Mullet, salted	26,600	800			408,390	13,128	5,000	100
Mullet roe, salted	1,600	64			12,350	587		
Pig-fish			1,500	45				
Pompano	5,541	277	1,700	94	5,960	301	3,000	180
Sardines			800	8				
Sheepshead	4,200	126	1,200	36	7,200	163	5,865	88
Snappers, gray, etc			200	6			520	8
Spanish mackerel, fresh	52,780	2,111	92,000	2,760	14,580	586	16,133	807
Spot			2,900	61				
Trout or squeteague, fresh	23,500	705	2,950	148	72,100	1,933	76,000	1,900
Trout or squeteague, salted	2,660	80			13,278	444		
Whiting					200	2	880	13
Yellow-tail			4,300	129				
Shrimp					17,280	288		
Terrapin					200	4		
Total	210,081	7,679	305,427	9,061	946,237	22,989	504,589	6,854

Species.	Manatee.		Monroe.		Santa Rosa.		Wakulla.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish			1,000	$25	150	$3		
Angel-fish	2,731	$34						
Black bass					400	20		
Blue-fish, fresh			1,300	65	8,000	160		
Channel bass	30,000	375			800	40	13,300	$266
Drum	6,100	77						
Flounders					200	6	3,050	61
Groupers			28,500	855				
Grunts			58,900	2,945				
Hound-fish			6,000	360				
Lady-fish			110,000	4,200	10,000	150		
Moon-fish			2,000	80	270	8		
Mullet, fresh	494,000	4,940	20,000	600	10,900	408	261,375	5,288
Mullet, salted	150,000	2,000						
Mullet roe, salted	10,962	438						
Pike					175	9		
Pompano	300	18	4,000	600				
Porgy			3,200	160				
Pork-fish			300	24				
Sailor's choice			48,000	1,440				
Sardines			9,800	480				
Sheepshead	11,300	141	150	8				
Snappers, gray, etc			25,200	1,512				
Spanish mackerel, fresh	12,400	620	8,915	446			2,685	54
Spot					300	6		
Sun-fish					500	25		
Trout or squeteague, fresh	93,525	2,338			2,800	140	15,200	304
Whiting	1,690	21						
Yellow-tail	1,200	16	1,000	70	100	3		
Crawfish			14,664	1,222				
Terrapin					540	5		
Total	814,208	11,018	342,929	15,092	35,135	983	298,610	5,973

Table showing the yield of the shore seine fisheries of the west coast of Florida in 1902—Continued.

Species.	Walton.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish					1,150	$28
Angel-fish	500	$10	2,400	$48	9,996	178
Black bass					400	20
Blue-fish, fresh	37,000	615	65,100	1,953	247,390	7,506
Blue-fish, salted			3,000	120	3,000	120
Butter-fish					1,034	14
Channel bass	1,600	48	6,000	120	97,715	1,801
Crevalle	6,500	65			26,950	273
Drum					8,615	111
Flounders	500	15	8,900	178	21,640	495
German carp					675	13
Groupers					28,500	855
Grunts					58,900	2,945
Hound-fish					6,000	360
Jurel	8,200	86	500	10	24,750	257
Lady-fish			482,800	6,262	674,800	11,652
Menhaden	1,000	10			2,500	25
Moon-fish	800	24	2,500	50	9,845	294
Mullet, fresh	5,000	150	463,000	8,800	2,026,383	31,184
Mullet, salted			104,500	4,180	694,490	20,208
Mullet roe, salted			9,850	493	34,762	1,582
Pig-fish	500	15			2,000	60
Pike					175	9
Pompano	600	30	15,901	795	37,002	2,295
Porgy					3,200	160
Pork-fish					300	24
Sailor's choice					48,000	1,440
Sardines	1,000	10			11,600	498
Sheepshead	600	18	33,100	993	63,615	1,573
Snappers, gray, etc	210	6			26,130	1,532
Spanish mackerel, fresh	30,600	918	213,045	8,577	443,138	16,879
Spanish mackerel, salted			30,500	1,220	30,500	1,220
Spot	800	16			4,000	83
Sun-fish					500	25
Trout or squeteague, fresh	900	45	133,500	4,005	420,475	11,518
Trout or squeteague, salted			21,400	856	37,338	1,380
Whiting					2,770	36
Yellow-tail	1,400	42			8,000	260
Crawfish					14,664	1,222
Shrimp					17,280	288
Terrapin					740	79
Turtle	400	16			400	16
Total	98,110	2,139	1,595,996	38,660	5,151,322	120,448

Table showing the yield of the shore gill-net fisheries of the west coast of Florida in 1902.

Species.	Calhoun.		Citrus.		De Soto.		Escambia.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			800	$16	2,700	$34		
Black bass			750	19				
Blue-fish					5,000	100	6,700	$104
Channel bass			68,100	1,305	90,000	1,150		
Crevalle			900	15				
Drum			21,950	424	10,000	125		
Mullet, fresh	54,000	$810	1,015,000	17,398	1,175,166	11,752		
Mullet, salted	156,000	4,680	27,000	540				
Mullet roe, salted	2,400	96	700	28				
Pompano			400	32	15,000	600		
Sheepshead			129,800	2,659	103,146	1,289		
Snappers, gray, etc			113,909	2,209	18,000	225		
Spanish mackerel, fresh			1,000	60	8,000	400	31,825	906
Sturgeon							259,171	4,326
Caviar							3,491	1,753
Sun-fish			500	10				
Trout or squeteague, fresh	10,200	306	157,944	3,092	100,787	2,016		
Whiting					2,000	25		
Turtle							80	2
Total	222,600	5,892	1,538,753	27,807	1,529,799	17,716	301,267	7,091

Table showing the yield of the shore gill-net fisheries of the west coast of Florida in 1902—Continued.

Species.	Franklin.		Hernando.		Hillsboro.		Lafayette.		Lee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			110	$2	1,600	$25			5,000	$63
Blue-fish			100	2	3,400	86			7,100	142
Butter-fish					1,146	17				
Channel bass	4,500	$90	16,000	240	24,313	381			78,000	975
Crevalle			500	8	380	6				
Drum			3,700	55	4,440	67			8,800	110
Mullet, fresh	730,700	9,798	127,000	2,540	1,633,176	16,036	640,000	$12,800	2,520,304	25,203
Mullet, salted	118,190	3,888	48,000	960	166,487	4,284	140,000	4,200	72,000	1,050
Mullet roe, salted	3,450	167	5,000	250	7,250	278	13,800	690	4,500	270
Pompano					41,886	2,508			137,176	5,487
Sheepshead	1,000	30	4,200	126	33,026	495			240,000	3,000
Snappers, gray, etc			7,000	140	10,940	165			12,000	150
Spanish mackerel, fresh	4,600	184			44,941	2,276			48,706	2,435
Spanish mackerel, salted	10,050	402								
Sturgeon	71,120	3,706								
Caviar	1,950	1,073								
Trout or squeteague, fresh	8,550	257	12,000	240	61,610	1,560			223,970	4,479
Trout or squeteague, salted	8,760	324								
Whiting					100	2			2,000	25
Terrapin					600	50				
Turtle	800	56								
Total	966,670	19,975	223,610	4,563	2,035,295	28,236	793,800	17,690	3,359,556	43,389

Species.	Levy.		Manatee.		Monroe.		Pasco.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish	4,000	$60	13,610	$169			280	$6
Blue-fish	25,900	1,166	20,400	408			6,900	267
Channel bass	88,667	1,333	175,444	2,194			13,500	203
Crevalle	13,300	201					1,185	19
Drum	49,100	737	48,200	602			3,000	45
Lady-fish					500	$5		
Mullet, fresh	4,269,448	85,389	1,720,000	17,200	90,000	2,700	797,528	15,551
Mullet, salted	25,000	750	225,369	3,005				
Mullet roe, salted	1,200	60	23,010	920				
Pompano	2,174	174	225,650	13,539			410	23
Sheepshead	95,219	2,857	105,810	1,323			11,700	341
Snappers, gray, etc	60,433	1,432	27,700	346			10,600	212
Spanish mackerel, fresh	10,126	608	135,060	6,753			4,890	294
Sturgeon	10,000	500						
Caviar	250	200						
Trout or squeteague, fresh	103,141	2,779	219,650	5,491			38,000	760
Whiting	200	3	5,784	72				
Yellow-tail			800	10				
Terrapin			450	38				
Turtle	29,908	2,800						
Total	4,788,066	101,049	2,946,937	52,070	90,500	2,705	887,993	17,721

Species.	Taylor.		Wakulla.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish							28,100	$375
Black bass							750	19
Blue-fish							75,500	2,275
Butter-fish							1,146	17
Channel bass			3,000	$60			561,524	7,931
Crevalle							16,265	249
Drum							149,190	2,165
Lady-fish							500	5
Mullet, fresh	1,503,100	$30,062	631,250	12,625	121,767	$2,210	17,028,439	262,074
Mullet, salted	221,000	6,630			653,064	25,838	1,852,110	55,825
Mullet roe, salted	18,800	940			18,465	924	98,575	4,623
Pompano							422,696	22,363
Sheepshead	8,000	160					731,901	12,280
Snappers, gray, etc							260,582	4,879
Spanish mackerel, fresh							289,148	13,916
Spanish mackerel, salted							10,050	402
Sturgeon							343,291	8,532
Caviar							5,691	3,026
Sun-fish							500	10
Trout or squeteague, fresh	5,000	100			19,900	597	960,752	21,677
Trout or squeteague, salted					8,000	320	16,760	644
Whiting							10,084	127
Yellow-tail							800	10
Terrapin							1,050	88
Turtle							30,788	2,858
Total	1,755,900	37,892	634,250	12,685	821,196	29,889	22,896,192	426,370

Table showing the yield of the shore stop-net fisheries of the west coast of Florida in 1902.

Species.	De Soto.		Hernando.		Hillsboro.		Lee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish	1,000	$13			2,210	$33	2,800	$35
Blue-fish					600	15		
Butter-fish					960	15		
Channel bass	37,329	467			57,892	868	85,000	1,063
Crevalle					200	3		
Drum	4,100	52			4,020	61	10,000	125
Flounders					1,914	45		
Mullet	375,054	3,751	41,100	$822	320,904	3,110	1,338,797	13,388
Pompano					4,815	271		
Sailor's choice	3,000	40			200	3	5,000	63
Sheepshead	55,992	700			84,806	1,273	159,981	2,000
Snappers, gray, etc					3,960	59		
Spanish mackerel					600	30		
Sun-fish	800	12						
Whiting	1,000	15			400	6	2,000	25
Yellow-tail	657	8					1,200	15
Trout or squeteague	25,000	500			35,132	879	75,000	1,500
Terrapin					1,800	150		
Total	503,932	5,558	41,100	822	520,413	6,821	1,679,778	18,214

Species.	Levy.		Manatee.		Pasco.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish			3,100	$39			9,110	$120
Blue-fish							600	15
Butter-fish							960	15
Channel bass			164,000	2,050			344,221	4,448
Crevalle							200	3
Drum			16,900	212			35,020	450
Flounders			1,100	22			3,014	67
Mullet	40,000	$800	892,410	8,924	21,000	$420	3,029,265	31,215
Pompano							4,815	271
Sailor's choice			1,171	15			9,371	121
Sheepshead			262,100	3,402			562,879	7,375
Snappers, gray, etc							3,960	59
Spanish mackerel							600	30
Sun-fish							800	12
Whiting			3,500	44			6,900	90
Yellow-tail			1,200	15			3,057	38
Trout or squeteague			163,000	4,075			298,132	6,954
Terrapin			2,250	188			4,050	338
Total	40,000	800	1,510,731	18,986	21,000	420	4,316,954	51,621

Table showing the yield of the shore trammel-net fisheries of the west coast of Florida in 1902.

Species.	Escambia.		Hillsboro.		Santa Rosa.		Walton.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Angel-fish	1,450	$29							1,450	$29
Black bass	1,200	60			700	$35	1,100	$55	3,000	150
Blue-fish	5,700	104	1,200	$30	3,000	60			9,900	194
Channel bass	4,305	178	7,667	115	200	8			12,172	301
Crevalle	5,000	55			1,700	17			6,700	72
Flounders	752	23							752	23
Jurel	3,490	38							3,490	38
Moon-fish	383	12							383	12
Mullet	12,700	381			2,000	60	11,600	390	26,300	831
Pompano	3,410	175	12,222	611	100	6			15,732	792
Sheepshead	657	21	3,913	59	180	5			4,750	85
Snappers, gray, etc	250	8							250	8
Spanish mackerel	700	21							700	21
Spot	8,700	174			400	8			9,100	182
Sun-fish	2,100	105					450	23	2,550	128
Trout or squeteague	6,900	345	4,155	104	700	35	4,700	198	16,455	682
Total	57,697	1,729	29,157	919	8,980	234	17,850	666	113,684	3,548

Table showing the yield of the shore cast-net fisheries of the west coast of Florida in 1902.

Specie.	Escambia.		Franklin.		Hillsboro.		Monroe.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Channel bass					4,100	$63			4,100	$63
Drum					800	12			800	12
Flounders	175	$5							175	5
Mullet	4,100	121	57,000	$743					61,100	864
Sardines							18,000	$500	18,000	500
Sheepshead					700	11			700	11
Snappers, mangrove, etc					2,000	30			2,000	30
Spot	1,000	20							1,000	20
Crawfish							20,700	1,150	20,700	1,150
Total	5,275	146	57,000	743	7,600	116	38,700	1,650	108,575	2,655

Table showing the yield of the shore trap-net fisheries of the west coast of Florida in 1902.

Specie.	Franklin.		Monroe.		Total.	
	Lbs.	Value.	Lbs	Value.	Lbs.	Value.
Angel-fish			15,500	$775	15,500	$775
Cat-fish	50,000	$1,000			50,000	1,000
Grouper			45,000	1,350	45,000	1,350
Grunt			48,000	2,400	48,000	2,400
Hog-fish			15,000	750	15,000	750
Jurel			200	10	200	10
Margate-fish			1,800	66	1,800	66
Porgy			9,180	459	9,180	459
Pork-fish			11,035	885	11,035	885
Sailor's choice			9,375	375	9,375	375
Snappers, grey, etc			22,500	1,350	22,500	1,350
Sun-fishes			1,500	75	1,500	75
Tang			200	10	200	10
Trunk-fish			300	12	300	12
Turbot			300	24	300	24
Yellow-tail			17,142	1,200	17,142	1,200
Crab, stone			3,214	225	3,214	225
Crawfish			12,500	500	12,500	500
Total	50,000	1,000	212,746	10,466	262,746	11,466

Table showing the yield of the shore line fisheries of the west coast of Florida in 1902.

Specie.	Citrus.		Escambia.		Franklin.		Hillsboro.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	6,500	$165			2,000	$100		
Cat-fish					15,000	300		
German carp					500	20		
Groupers			8,045	$80			13,200	$169
Grunts							17,300	254
King-fish							2,700	108
Sea bass							3,800	38
Snapper, red			91,830	2,733			8,100	324
Suckers					300	12		
Sun-fishes	4,100	82			2,950	118		
Trout, or squeteague			700	35				
Other fish					250	10		
Total	10,600	247	100,575	2,848	21,000	560	45,100	893

Table showing the yield of the shore line fisheries of the west coast of Florida in 1902—Continued.

Specie.	Levy.		Monroe.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amber-fish			34,600	$865	34,600	$865
Angel-fish			750	38	750	38
Barracuda			21,435	750	21,435	750
Black bass					8,500	265
Blue-fish			8,100	405	8,100	405
Bonito			8,100	405	8,100	405
Cat-fish	6,000	$150			21,000	450
Crevalle			4,500	45	4,500	45
German carp					500	20
Groupers	500	8	52,950	1,623	74,695	1,880
Grunts	2,000	30	240,000	12,000	259,300	12,284
Hog-fish			48,290	2,391	48,290	2,391
Jurel			1,585	64	1,585	64
King-fish			122,000	3,050	124,700	3,158
Margate-fish			1,700	156	1,700	156
Mutton-fish			27,501	825	27,501	825
Permit			1,800	90	1,800	90
Pompano			2,000	300	2,000	300
Porgy			56,880	2,844	56,880	2,844
Pork-fish			11,607	2,205	11,607	2,205
Sailor's choice			45,000	1,800	45,000	1,800
Sea bass	6,000	90			9,800	128
Snapper, red			4,200	105	104,130	3,162
Snappers, other			41,334	2,480	41,334	2,480
Spanish mackerel			19,000	950	19,000	950
Spot			150	15	150	15
Suckers			4,500	360	4,800	372
Sun-fishes			2,200	196	9,250	396
Trout, or squeteague			650	33	1,350	68
Turbot			550	42	550	42
Whiting			500	50	500	50
Yellow-tail			60,688	4,248	60,688	4,248
Other fish			150	6	400	16
Total	14,500	278	822,720	38,341	1,014,495	43,167

Table showing the quantity and value of oysters taken with tongs in the shore fisheries of the west coast of Florida in 1902.

County.	Lbs.	Value.
Citrus	64,596	$2,161
De Soto	90,650	4,887
Escambia	70,000	6,000
Franklin	2,498,160	68,588
Hillsboro	122,850	7,280
Levy	729,841	17,377
Santa Rosa	64,400	5,520
Wakulla	56,000	2,000
Washington	77,490	2,254
Total	3,773,987	116,067

Table showing the yield in the shore sponge fisheries of the west coast of Florida in 1902.

Specie.	Franklin.		Hillsboro.		Monroe.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Boat sponge					2,455	$1,473	2,455	$1,473
Glove sponge					5,892	889	5,892	889
Grass sponge	2,709	$569	34,076	$7,156	29,221	6,185	66,006	13,910
Sheepswool sponge	794	2,144	9,948	26,860	47,413	90,247	58,155	119,251
Yellow sponge	1,085	597	3,056	1,681	25,577	14,010	29,718	16,288
Wire sponge, etc					230	46	230	46
Total	4,588	3,310	47,080	35,697	110,788	112,850	162,456	151,857

Table showing the catch by miscellaneous apparatus in the shore fisheries of the west coast of Florida in 1902.

Specie.	Citrus.		De Soto.		Escambia.		Franklin.		Hillsboro.		Lee.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Cat-fish					4,800	$240						
Flounders							50,000	$1,500				
Alligator hides	400	$27	3,600	$240			7,500	875			30,600	$2,040
Crab, blue, hard					1,333	83						
Crab, blue, soft					280	84						
Crab, stone									800	$40		
Otter skins	16	90	100	250							210	525
Terrapin			9,000	1,200			3,000	260				
Total	416	117	12,700	1,690	6,413	407	60,500	2,635	800	40	30,810	2,565

Specie.	Levy.		Monroe.		Wakulla.		Washington.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Angel-fish			6,000	$300					6,000	$300
Barracuda			11,700	410					11,700	410
Cat-fish									4,800	240
Flounders					4,100	$82			54,100	1,582
Permit			8,100	405					8,100	405
Allegator hides	6,900	$450					5,400	$477	54,400	4,109
Clam	240	30	560	70					800	100
Conch			3,334	890					3,334	890
Crab, blue, hard									1,333	83
Crab, blue, soft									280	84
Crab, stone			7,667	1,534					8,467	1,574
Crawfish			7,200	376					7,200	376
Otter skins	30	150							356	1,015
Terrapin	10,800	1,800	2,259	532					25,059	3,792
Tortoise-shell			435	1,522					435	1,522
Turtle			125,193	9,069					125,193	9,069
Turtle eggs			400	66					400	66
Total	17,970	2,430	172,848	15,174	4,100	82	5,400	477	311,957	25,617

THE WHOLESALE TRADE.

In the wholesale trade in fishery products Hillsboro County leads, with Monroe second and De Soto third. In the two first-named counties the sponge-buying industry of Tarpon Springs and Key West form the principal part of the trade.

Table showing the extent of the wholesale trade in fishery products for the west coast of Florida in 1902.

Items.	Citrus.		De Soto.		Franklin.		Hillsboro.		Levy.		Monroe.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	3	$1,350	7	$5,650	1	$1,300	14	$42,075	3	$6,100	13	$81,250	41	$137,725
Cash capital		3,000		41,250		8,000		232,500		20,000		145,000		449,750
Ice used		1,638		13,560				8,850		1,740				25,788
Wages paid		1,750		17,664		4,000		30,459		6,550		15,203		75,626
Employees	10		42		11		95		25		65		248	

THE CANNING INDUSTRY.

There were 3 canneries in operation on the west coast of Florida in 1902, two for oysters and one for turtles. There is another cannery in this region—at Gulf City—but it was not operated in 1902, although it was in operation in 1903.

Items.	No.	Value.
Establishments	3	$37,950
Cash capital		42,500
Wages paid		20,820
Employees	202	
Oysters utilized ... bushels	265,000	47,150
Green turtle utilized	317,000	9,510
Oysters as sold:		
1-pound cans	1,417,000	83,250
2-pound cans	154,400	17,930
Shucked ... gallons	10,000	8,500
Green turtle as sold:		
Turtle soup (2-pound cans)	240	72
Turtle soup (3-pound cans)	1,584	792
Turtle meat (2-pound cans)	3,120	2,340
Turtle meat (3 pound cans)	10,272	12,840

NOTES ON CERTAIN FISHERIES.

The mullet fishery.—This fishery is now in a prosperous condition, but in 1897, when the last canvass was made, it was greatly impaired, owing to interruption of the trade by the Cuban revolution. For many years the mullet fishermen have salted a large part of their catch and shipped it to Cuba, where it found a ready sale; but in 1896 this business was practically abandoned on account of the high tariff on fish imported into the island. After the war closed the mullet trade began to revive. The fishermen and dealers have recently been making an effort to increase their business, and have met with such success that there are now few places of importance south of North Carolina and the Ohio River, and east of the Mississippi River, to which Florida mullet are not shipped. Punta Gorda is especially noteworthy for the enterprise exhibited in this direction. A few years ago the shipments from there were insignificant, but in 1902 they amounted to 224½ carloads and 10,855 barrels of fish, with an approximate weight of 7,547,000 pounds, the greater part of which was mullet. The fish are shipped in carload lots to agents or dealers at certain points, who pack them in boxes and barrels and ship them to adjacent localities, this method resulting in a considerable saving in freight charges. In shipping mullet, an ordinary box-car is used, having a partition across it at both sides of the doors, to form a compartment at each end of the car. Alternating layers of mullet and cracked ice are placed in these inclosures until the car contains a load of 24,000 pounds of fish.

Although fishing in state waters by foreign vessels is prohibited, at the present time Cuban vessels fish along the shores of the west coast of Florida, the sparse population and the general absence of revenue cutters making it easy to escape interruption. The Cuban

fishermen often fish in the bays, and sometimes even camp on the shores, in order to prepare their fish.

The following table gives the yield of the mullet fishery of the west coast of Florida in various years from 1879 to 1902:

Items.	1879.	1880.	1889.	1890.	1895.	1897.	1902.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Mullet, fresh	1,058,083		8,794,586	10,650,959	12,310,953	11,639,615	22,223,685
Mullet, salted	2,504,422		2,728,785	2,968,254	5,714,134	2,503,703	2,589,190
Mullet, smoked			4,500	3,200			
Mullet roe, fresh					2,150		
Mullet roe, salted	6,662		244,080	298,549	299,061	143,999	134,887
Total	3,569,167	2,028,250	11,771,951	13,920,962	18,326,298	14,287,317	24,947,762

The oyster fishery.—But little attention has been given to the planting of oysters in this region, owing to the hostility displayed by a certain element among the oystermen. In 1902, 20,000 bushels were planted in East Bay, near Apalachicola, making the first planted bed of large size in this section. A few small areas were planted in Big Bayou, an arm of Tampa Bay, but the drought of 1902 killed most of them.

Two canneries were operated in Apalachicola in 1902, one of which, at Gulf City, was closed during that year, owing to the illness and subsequent death of the owner, but it was reopened in 1903.

The following is a summary of the catch of oysters for certain years:

	Bushels.	Value.
1889	294,871	$75,189
1890	371,081	93,692
1895	170,518	46,308
1897	179,715	50,258
1902	543,637	117,399

Since 1895 the catch has shown a steady increase, and in 1902 it was larger than in any previous year for which statistics are available.

The red-snapper fishery.—While this fishery still centers at Pensacola, it is becoming quite important at Tampa, and is also prosecuted incidentally at St. Petersburg, Apalachicola, and Key West. The catch in Santa Rosa County is virtually a part of the Pensacola industry, as the vessels and boats sail from there, and the catch is sold to the Pensacola dealers.

The following summary shows the value of red snappers caught on the gulf coast of Florida in certain years:

Year.	Lbs.	Value.
1889	3,469,370	$105,557
1890	4,172,942	123,799
1895	4,886,396	154,536
1897	5,314,487	171,234
1902	8,074,066	237,428

These figures indicate that the fishery is steadily increasing in importance. The catch in 1902 would have been even larger had it not been for a strike on the part of the Fishermen's Union at Pensacola, which lasted from November 27, 1901, to January 18, 1902. The first vessel to land fish came in on February 3. One Pensacola vessel—the schooner *Contest*—was lost in February on her first trip of the season.

Groupers are also taken in this fishery, being found on the banks in company with the red snappers, but as the fishermen receive only 1 cent a pound for them, not many are brought in.

The sponge fishery.—This industry, which centers largely at Key West and Tarpon Springs, is prosecuted exclusively in Florida, and is one of the most important in the state. It has fluctuated considerably in recent years, however, and, as a whole, seems to be on the decline. The season of 1902 was an especially poor one, although a larger fleet of vessels and boats was engaged than in many previous years.

The following table shows the catch in this fishery for certain years:

Kinds.	1880.		1889.		1890.		1895.		1896.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Sheepswool							231,272	$363,107	149,724	$248,196
Yellow							29,509	11,798	23,655	9,318
Grass							21,387	5,464	44,617	11,508
Other							23,952	6,502	18,315	3,990
Total	207,000	$200,750	316,559	$381,087	366,772	$438,682	306,120	386,871	236,311	273,012

Kinds.	1897.		1899.		1900.		1901.		1902.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Sheepswool	157,476	$240,599	153,700	$332,390	181,311	$483,263	202,673	$422,561	133,518	$297,727
Yellow	32,362	13,082	55,800	16,205	74,466	44,045	62,512	39,290	56,787	31,113
Grass	128,622	29,188	76,900	14,319	143,112	33,263	108,748	24,210	140,682	29,765
Other	13,086	3,171	18,000	5,000	19,236	7,114	21,627	6,679	15,902	5,817
Total	331,546	286,040	304,400	367,914	418,125	567,685	395,560	492,740	346,889	364,422

The following table is interesting as showing the average price per pound received by the spongers for each variety of sponge for a series of years, and also the general average price for all grades. The year 1900 seems to have been the banner year for most varieties, and the

general average is also highest for that year. For 1902 it is the lowest shown, except for 1897. The price of yellow sponges fell considerably as compared with 1901, when quite a demand arose in railroad shops, etc., for this variety to take the place of sheepswool sponges. It was soon found that they would not answer the purpose, and as the buyers had secured a large supply in anticipation of the market, a glut resulted which caused the price to decline.

Kinds.	Average price per pound.						
	1895.	1896.	1897.	1899.	1900.	1901.	1902.
Sheepswool	$1.57	$1.66	$1.53	$2.16	$2.67	$2.08	$2.23
Yellow	.39	.40	.40	.29	.59	.63	.55
Grass	.26	.26	.23	.19	.23	.22	.21
Other	.27	.22	.24	.28	.37	.31	.37
Average	1.26	1.16	.86	1.21	1.36	1.25	1.05

The season of 1900 was especially good for the sponge trade, owing to the unusual clearness of the water, which permitted sponging on nearly every ground. The reverse was the case in 1902, and, in the spring, the spongers had to work on the "Bay" or "Gulf" grounds in from 50 to 60 feet of water, on what is known as the "Middle Bank." The "hookers," or men who handle the sponge hook, found this occupation so fatiguing that a number of them discontinued work on account of it, and as the supply of "hookers" is limited, the yield of sponges was correspondingly smaller. The sponges gathered in this depth were very large and of a fine quality, but at the time for marketing it was found that they could not be cut into very profitable sizes. The sponging on the "Key" grounds was very poor, owing to bad water and other causes. In January, February, and March the spongers found clear water on what is known as the "New Grounds," in the western part of the "Key" region, between Key West and Cape Sable. Most of the sponging here was done in from 12 to 18 feet of water, an unusual depth for this locality.

During the early part of 1902, at the season when the sponge vessels are generally laid up on account of bad weather in the "Bay," several Key West vessel owners undertook a trip to the Bahama Banks. These grounds are frequented by Bahaman spongers, but as they are 30 miles from the islands no interference from the colonial authorities was anticipated. On the arrival of the first Key West vessel, however, her captain was arrested and imprisoned in Nassau until the payment of a fine of $50, in view of which discouragement the rest of the vessels abandoned the enterprise.

The business of buying and preparing sponges for market is entirely separate and distinct from that of gathering them. The buyers, who represent wholesale firms in New York, Philadelphia, and St. Louis, have large warehouses in which the sponges receive their final clean-

ing and trimming and are baled for shipment. For many years Key West had almost a monopoly of this feature of the industry. Apalachicola and St. Marks dealt in sponges to a limited extent, but the first serious competitor with Key West was Tarpon Springs, where buying began in 1891. The sponge business rapidly expanded here until in 1901 it exceeded that of Key West by about $70,000, while in 1902 the excess was much greater. The "Bay" spongers find it much more convenient to sell at Tarpon Springs than at Key West, while the latter point is naturally the market for the "Key" spongers.

The sturgeon fishery.—At the time of the last general canvass of the fisheries of the gulf coast (1897), sturgeon were caught in but one county—Levy—and the catch in that year amounted to 9,254 pounds, valued at $331. These were all taken on the Suwanee River. No caviar was put up. When this fishery was canvassed for the year 1900 a considerable increase in its importance was noted. Fishing was prosecuted in the Suwanee, the Ocklocknee, and the Apalachicola rivers, the total yield being 165,500 pounds round weight, which sold for $9,786, while 4,270 pounds of caviar were prepared and sold for $3,115. During 1902 fishing was prosecuted in the Suwanee, the Ocklocknee, the Apalachicola, and in the Choctawatchee Bay and River, in Escambia Bay and River, and in Blackwater River. The new regions were first worked in 1901, and are at present the most prolific. The product in 1902 amounted to 343,291 pounds of sturgeon, valued at $8,532, and 5,691 pounds of caviar, valued at $3,026.

The turtle fishery.—This fishery is gradually becoming concentrated at Key West, in Monroe County. Quite a fleet of vessels engage in it, and fish not only on the Florida coast but also on the Honduras, Yucatan, and Mexican coasts. Three species, the green, the loggerhead, and the hawksbill are taken. The green turtle is the most sought after for food; the hawksbill furnishes the tortoise shell of commerce. The following table shows the extent of this fishery for a series of years:

Counties.	1880.	1889.	1890.	1895.	1897.	1902.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
De Soto			4,000			
Escambia						80
Franklin		100	2,250	3,850	2,144	800
Hillsboro		11,735	12,004	5,000		
Lee		3,500	3,000	4,375		
Levy		70,705	89,958	107,610	85,000	29,908
Manatee		60,665	60,665			
Monroe		291,695	297,157	410,142	546,752	339,164
Santa Rosa		740	7,000		720	
Walton						400
Washington		740				
Total	180,000	439,880	476,034	530,977	634,616	370,352

FISHERIES OF ALABAMA.

The coast fisheries of Alabama are prosecuted chiefly in Mobile Bay, Mississippi Sound, and the Gulf of Mexico. The only counties of the state located on the coast are Mobile County on the west and Baldwin County on the east of Mobile Bay.

The principal fishing center and distributing point for fishery products is the city of Mobile, on the west side of the bay. There are a number of smaller fishing localities along the coast, the more important of these being Bayou Labatre, Coden, and Dauphin Island in Mobile County, and Bon Secour and Daphne in Baldwin County.

The species taken in largest quantities in the fisheries of this state are oysters, red snappers, groupers, mullet, trout or squeteague, sturgeon, buffalo-fish, cat-fish, hard crabs, sheepshead, channel bass or red-fish, spots, croakers, black bass, flounders, and Spanish mackerel.

Oysters.—The natural oyster reefs of Alabama have been so thoroughly worked that many of the oystermen have for some years been turning their attention to oyster planting on private beds. This is particularly the case at Coden, Bayou Labatre, and Granite, in Mobile County, and at Bon Secour, Gasque, and Navy Cove, in Baldwin County. The seed oysters are taken mostly on the western side of the bay. No restriction is placed on the time of taking them, but they are usually secured during March, April, and May. The laws of Alabama allow oysters to be planted to a distance of 600 yards beyond low-water mark. They may be taken for market from the natural reefs at any time in the year, the fishermen being governed entirely by the demand, which is greatest from September 1 to April 15. Tongs are the only apparatus allowed in catching them. No oysters can be taken measuring less than 2½ inches from hinge to mouth, and the maximum quantity a single boat may take is 3,500 bushels per week. The vessels employed in transporting oysters from the grounds to market also engage more or less in oystering while waiting for a load. The greater part of the catch is taken to Mobile, but many are sold to transporting vessels from canneries in Mississippi. The prices ranged in 1902 from 40 cents paid by the Mississippi vessels, to 50 cents per barrel paid by those from Mobile. Oysters from the natural reefs on the western shore of Mobile Bay are called "western reefers," and those from the eastern side of the bay "eastern reefers."

Red snappers.—This fishery centers at Mobile, which in 1902 sent a fleet of seven vessels to the snapper banks. The prosecution of the industry has been pushed with much energy during recent years, and the number of vessels engaged, which vary in size from 24 to 60 net tons, is gradually increasing. Mobile vessels go as far east as Tampa, and westward to the coast of Mexico. The banks nearest to Mobile are about 10 miles from the mouth of the bay.

Snapper fishing is done in from 20 to 75 fathoms of water. The crew usually consists of from six to eight men, two men fishing from the vessel and the others from dories carrying two men each. This fishery is prosecuted practically during the entire year, except when the vessel is laid up for repairs. An average of three trips to the banks is made every two months, the aim being not to keep the fish longer than ten or twelve days after they are caught. Lady-fish and various other species are used for bait. On an average, a trip to the banks requires about $15 worth of bait, and if successful the vessel will return with from 2,500 to 3,000 red snappers, weighing from 5 to 30 pounds each. Large numbers of groupers are also brought in with each trip, but they command a comparatively low price. In 1902 the fishermen received 3½ cents per pound for snappers weighing 7 pounds and under, and 25 cents a piece for all others.

Other species.—Mullet forms a larger part of the products of the shore fisheries, in both weight and value, than any other species except oysters, and are also taken in considerable quantities in the vessel fisheries. The catch by vessels was 491,000 pounds, valued at $6,745, and by boats in the shore fisheries, 1,055,300 pounds, valued at $16,712. The principal apparatus employed for capture is the trammel net, but in the upper part of Mobile Bay, in shallow water, seines also are used. Trout, or squeteague, are quite abundant, the catch by vessels and boats aggregating 259,450 pounds, valued at $10,586. This fish is caught with trammel nets, seines, and lines. The fishery for sturgeon, in which much activity has been shown recently, is prosecuted from Mobile and vicinity, the product amounting to 100,000 pounds of sturgeon, valued at $3,930, and 5,000 pounds of caviar, valued at $2,000. The catch was obtained chiefly in the Mobile River by vessels and boats with gill nets. The yield of buffalo-fish was 108,100 pounds, valued at $2,251, and of cat-fish 150,750 pounds, valued at $3,821. A large number of other species were taken in smaller quantities.

Apparatus.—The most important forms of apparatus employed in the fisheries of Alabama, as shown in the value of the catch, are tongs, dredges, lines, trammel nets, seines, and gill nets. Tongs are the only apparatus which can be legally used within the state for catching oysters. The oysters shown in the present statistics as being caught with dredges were taken by Alabama vessels in Mississippi waters.

Lines are employed in both the vessel and shore fisheries, but the principal part of the catch thus taken consists of red snappers obtained in the vessel fisheries. In the shore fisheries lines are used mainly by negroes from Mobile fishing in Mobile River just above the city. Line fishing is followed about nine months of the year. During three months in the spring the water is too muddy to admit of profitable fishing; the best catches are made in the winter. Trammel nets are used considerably in the vessel fisheries, but much more exten-

sively by the small-boat fishermen, many of whom live in Mobile and vicinity. Seines also are used in both the vessel and shore fisheries, but principally in the latter. Gill nets are employed by vessels and boats in the capture of sturgeon.

In addition to the kinds of apparatus already referred to there are also a few minor appliances, among which are spears and nippers. Spears are used exclusively in catching flounders, which are taken at low tide, and only when the water is smooth. A fisherman will sometimes secure with a spear about 300 pounds of flounders in a night. Nippers are used in catching terrapin.

Persons engaged.—The total number of persons engaged in the fisheries of this state in 1902 was 1,098. Of this number 254 were employed on fishing vessels, 19 on transporting vessels, 441 in the shore fisheries, and 384 as shoresmen in wholesale fish establishments and shucking houses. Compared with 1897, the canvass for 1902 shows an increase of 309 men, or 39.16 per cent.

Investment.—The total amount of capital invested in the fisheries of this state in 1902 was $328,285, against $165,189 in 1897, an increase of $163,096, or 98.73 per cent. The investment included 77 fishing and transporting vessels, having a value, with their outfits, of $115,535; 317 boats in the shore fisheries valued at $11,942; fishing apparatus on vessels and boats to the value of $8,233; shore and accessory property valued at $135,075; and cash capital utilized in the wholesale fishery trade amounting to $57,500.

Products.—The products of the fisheries of Alabama in 1902 amounted to 9,351,447 pounds, having a value to the fishermen of $266,682. As compared with the returns for 1897, there has been an increase of 4,652,066 pounds, or 98.99 per cent, in quantity, and $132,244, or 98.14 per cent, in value. The increase was chiefly in the yield of the oyster, red snapper, and mullet fisheries.

The three tables which follow give, by counties, the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of Alabama in 1902:

Table showing, by counties, the number of persons employed in the fisheries of Alabama in 1902.

How engaged.	Baldwin.	Mobile.	Total.
On vessels fishing	92	162	254
On vessels transporting	2	17	19
Boat or shore fishermen	94	347	441
Shoresmen	....	384	384
Total	188	910	1,098

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Alabama in 1902.

Items.	Baldwin.		Mobile.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	30	$21,450	40	$64,600	70	$86,050
Tonnage	242		592		834	
Outfit		5,160		13,055		18,215
Vessels transporting	1	1,200	6	9,200	7	10,400
Tonnage	8		85		93	
Outfit		90		780		870
Boats	124	5,985	a 193	5,957	317	11,942
Apparatus—vessel fisheries:						
Seines	1	100	6	560	7	660
Trammel nets	19	635	4	200	23	835
Gill nets	4	80	4	120	8	200
Lines				650		650
Dredges	14	380	6	160	20	540
Tongs	60	359	75	420	135	779
Apparatus—shore fisheries:						
Seines	2	135	4	225	6	360
Trammel nets	46	885	55	1,020	101	1,905
Gill nets	3	60	8	240	11	300
Lines		29		131		160
Tongs	43	268	271	1,570	314	1,838
Nippers and spears		1		5		6
Shore and accessory property		300		134,775		135,075
Cash capital				57,500		57,500
Total		37,117		291,168		328,285

a Includes 1 gasoline boat, valued at $700.

Table showing, by counties and species, the yield of the fisheries of Alabama in 1902.

Species.	Baldwin.		Mobile.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	11,900	$1,010	24,150	$2,208	36,050	$3,218
Blue-fish	4,275	141	16,750	564	21,025	705
Buffalo-fish	35,000	700	73,100	1,151	108,100	2,251
Cat-fish	56,850	1,199	93,900	2,622	150,750	3,821
Channel bass or redfish	30,915	1,164	39,400	1,558	70,315	2,722
Crappie	2,150	107	9,300	650	11,450	757
Crevalle	2,125	35	3,250	48	5,375	73
Croaker	28,200	550	29,700	607	57,900	1,157
Drum, fresh-water	850	43	1,200	53	2,050	96
Drum, salt-water	3,110	55	1,800	37	4,910	92
Flounders	22,400	803	13,700	527	36,100	1,330
Groupers			635,000	6,350	635,000	6,350
Jew-fish			2,000	40	2,000	40
Jurel			200	4	200	4
King-fish			800	23	800	23
Lady-fish	725	12	650	11	1,375	33
Mangrove snapper	550	14			550	14
Menhaden			10,000	25	10,000	25
Moon-fish			800	10	800	10
Mullet	870,800	12,650	675,500	10,807	1,546,300	23,457
Pig-fish	6,150	109	12,800	240	18,950	349
Pike or pickerel	400	20	1,100	70	1,500	90
Pin-fish	7,900	123	4,600	86	12,500	209
Pompano	5,550	473	5,250	356	10,800	829
Red snapper			3,466,500	69,331	3,466,500	69,331
Sea bass	1,350	54	2,500	97	3,850	151
Shad	150	3			150	3
Sheepshead	22,350	815	52,700	2,005	75,050	2,820
Spade-fish	400	13	2,050	64	2,450	77
Spanish mackerel	3,600	137	30,050	1,148	33,650	1,285
Spot	25,450	419	38,400	616	63,850	1,035
Strawberry bass	2,550	127	12,400	880	14,950	1,007
Sturgeon	10,000	330	90,000	3,600	100,000	3,930
Caviar			5,000	2,000	5,000	2,000
Sun-fishes	3,600	178	13,600	940	17,200	1,118
Trout	99,250	4,161	160,200	6,425	259,450	10,586
Warmouth	4,000	193	14,200	962	18,200	1,155
Whiting	10,550	202	14,350	280	24,900	482
Yellow-tail	50	1	275	5	325	6
Shrimp	200	12			200	12
Crab, hard	9,830	258	65,400	1,960	a 75,230	2,218
Terrapin	450	105	6,020	1,808	b 6,470	1,913
Turtle	1,000	20	6,000	105	7,000	125
Oyster, natural	156,297	20,152	1,899,015	60,146	c 2,055,312	80,298
Oyster, planted	29,315	8,605	347,595	30,870	d 376,910	39,475
Total	1,470,242	54,993	7,881,205	211,689	9,351,447	266,682

a 225,690 in number. b 3,597 in number. c 293,616 bushels. d 53,844 bushels.

VESSEL AND SHORE FISHERIES.

The yield of the vessel fisheries amounted to 5,199,802 pounds, valued at $137,745. A very large proportion of this quantity consisted of red snappers and other species taken in the red-snapper fishery. In the shore fisheries the catch was 4,151,645 pounds, valued at $128,937, considerably more than half of which was composed of oysters.

The products of the vessel and shore fisheries are presented separately by counties in the following tables:

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of Alabama in 1902.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Blue-fish	3,200	$105	14,150	$491	17,350	$596
Cat-fish	200	4	1,000	18	1,200	22
Channel bass or red-fish	1,500	52	10,900	462	12,400	514
Crevalle	200	4	850	15	1,050	19
Croaker	2,000	30	11,300	190	13,300	220
Drum, salt-water	150	3	950	17	1,100	20
Flounders	700	25	3,750	132	4,450	157
King-fish			700	20	700	20
Lady-fish			550	9	550	9
Mullet	32,000	400	174,000	2,390	206,000	2,790
Pig-fish	1,800	33	9,700	187	11,500	220
Pin-fish	200	4	950	17	1,150	21
Pompano	200	18	1,050	103	1,250	121
Sea bass	200	7	950	39	1,150	46
Sheepshead	6,500	165	37,500	1,400	44,000	1,565
Spade-fish	200	3	950	30	1,150	33
Spanish mackerel	3,200	115	29,700	1,128	32,900	1,243
Spot	3,400	52	25,600	403	29,000	455
Trout	10,000	350	59,300	2,431	69,300	2,781
Whiting	400	8	1,950	38	2,350	46
Yellow-tail			275	5	275	5
Turtle	1,000	20	4,000	80	5,000	100
Total	67,050	1,398	390,075	9,605	457,125	11,003
Trammel nets:						
Blue-fish	1,025	34	650	22	1,675	56
Cat-fish	10,800	197	2,600	50	13,400	247
Channel bass or red-fish	22,400	836	11,300	453	33,700	1,289
Crevalle	450	8			450	8
Croaker	12,200	199	2,600	45	14,800	244
Drum, salt-water	1,500	25	650	12	2,150	37
Flounders	7,800	311	1,900	79	9,700	390
King-fish			100	3	100	3
Lady-fish	350	6	100	2	450	8
Mangrove snapper	50	1			50	1
Mullet	201,000	2,780	84,000	1,175	285,000	3,955
Pig-fish	3,500	60	2,400	45	5,900	105
Pin-fish	5,700	83	2,600	48	8,300	131
Pompano	5,000	435	3,250	185	8,200	620
Sea bass	1,000	40	650	26	1,650	66
Sheepshead	9,000	348	3,900	160	12,900	508
Spot	12,250	197	2,600	48	14,850	245
Trout	22,400	822	8,400	325	30,800	1,147
Whiting	5,150	83	2,600	55	7,750	138
Total	321,575	6,465	130,300	2,733	451,875	9,198
Gill nets:						
Sturgeon	6,000	210	40,000	1,600	46,000	1,810
Caviar			2,000	800	2,000	800
Total	6,000	210	42,000	2,400	48,000	2,610
Lines:						
Groupers			635,000	6,350	635,000	6,350
Jew-fish			2,000	40	2,000	40
Red snapper			3,466,500	69,331	3,466,500	69,331
Total			4,103,500	75,721	4,103,500	75,721

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of Alabama in 1902—Continued.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Dredges:						
Oyster, natural	39,925	$6,150	11,900	$2,200	51,825	$8,350
Tongs:						
Oyster, natural	36,222	10,302	38,765	10,471	74,987	20,773
Oyster, private	7,615	6,525	4,875	3,565	12,490	10,090
Total	43,837	16,827	43,640	14,036	87,477	30,863
Grand total	478,387	31,050	4,721,415	106,695	5,199,802	137,745

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Alabama in 1902.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Blue-fish			1,500	$37	1,500	$37
Cat-fish	600	$12			600	12
Channel bass or red-fish	315	17	3,000	105	3,315	122
Crappie	50	3			50	3
Crevalle	200	4	300	4	500	8
Croaker	600	13	2,000	25	2,600	38
Drum, fresh-water	50	3			50	3
Drum, salt-water	235	5			235	5
Flounders	100	7	150	5	250	12
Lady-fish	100	2			100	2
Mangrove snapper	100	5			100	5
Menhaden			10,000	25	10,000	25
Mullet	1,800	45	2,500	32	4,300	77
Pig-fish			200	2	200	2
Pompano	300	15	200	14	500	29
Sea bass			500	18	500	18
Shad	150	3			150	3
Sheepshead	350	17	1,200	42	1,550	59
Spade-fish	200	10	500	17	700	27
Spanish mackerel	300	15			300	15
Spot	150	3	3,000	37	3,150	40
Strawberry bass	50	3			50	3
Sun-fishes	100	5			100	5
Trout	4,900	247	10,000	282	14,900	529
Warmouth	100	5			100	5
Whiting	200	4	1,500	19	1,700	23
Yellow-tail	50	1			50	1
Shrimp	200	12			200	12
Crab, hard	230	18	800	10	1,030	28
Terrapin			1,700	294	1,700	294
Turtle			2,000	25	2,000	25
Total	11,430	474	41,050	993	52,480	1,467
Trammel nets:						
Black bass	9,400	800	14,150	1,208	23,550	2,008
Blue-fish	50	2	450	14	500	16
Buffalo-fish	35,000	700	53,100	1,051	88,100	1,751
Cat-fish	44,500	971	60,300	1,354	104,800	2,325
Channel bass or red-fish	5,500	199	12,700	486	18,200	685
Crappie	2,100	104	3,000	150	5,100	254
Crevalle	1,275	19	2,100	29	3,375	48
Croaker	12,900	298	13,200	339	26,100	637
Drum, fresh-water	800	40	1,200	53	2,000	93
Drum, salt-water	975	17	200	8	1,175	25
Flounders	8,800	335	4,400	186	13,200	521
Jurel			200	4	200	4
Lady-fish	275	4			275	4
Moon-fish			800	10	800	10
Mullet	636,000	9,425	415,000	7,210	1,051,000	16,635
Pig-fish	850	16	500	6	1,350	22
Pike, or pickerel	400	20	600	30	1,000	50
Pin-fish	2,000	36	1,050	21	3,050	57
Pompano	50	5	750	54	800	59
Sea bass	150	7	400	14	550	21
Sheepshead	5,300	225	8,600	351	13,900	576
Spade-fish			600	17	600	17

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Alabama in 1902—Continued.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Trammel nets—Continued.						
Spanish mackerel	100	$7	350	$20	450	$27
Spot	9,650	167	7,200	128	16,850	295
Strawberry bass	2,500	124	3,600	180	6,100	304
Sun-fishes	3,500	173	4,800	240	8,300	413
Trout	44,450	1,912	70,500	2,967	115,250	4,879
Warmouth	3,900	188	5,400	262	9,300	450
Whiting	4,300	97	8,300	168	12,600	265
Terrapin			800	135	800	135
Total	834,725	15,891	694,250	16,695	1,528,975	32,586
Gill nets:						
Sturgeon	4,000	120	50,000	2,000	54,000	2,120
Caviar			3,000	1,200	3,000	1,200
Total	4,000	120	53,000	3,200	57,000	3,320
Lines:						
Black bass	2,500	210	10,000	1,000	12,500	1,210
Buffalo-fish			20,000	500	20,000	500
Cat-fish	750	15	30,000	1,200	30,750	1,215
Channel bass or red-fish	1,200	60	1,500	52	2,700	112
Crappie			6,300	500	6,300	500
Croaker	500	10	600	8	1,100	18
Drum, salt-water	250	5			250	5
Mangrove snapper	400	8			400	8
Pike, or pickerel			500	40	500	40
Sheepshead	1,200	60	1,500	52	2,700	112
Strawberry bass			8,800	700	8,800	700
Sun-fishes			8,800	700	8,800	700
Trout	17,500	830	12,000	420	29,500	1,250
Warmouth			8,800	700	8,800	700
Whiting	500	10			500	10
Crab, hard	9,600	240	64,600	1,950	74,200	2,190
Total	34,400	1,448	173,400	7,822	207,800	9,270
Tongs:						
Oyster, natural	80,150	3,700	1,848,350	47,475	1,928,500	51,175
Oyster, planted	21,700	2,080	342,720	27,305	364,420	29,385
Total	101,850	5,780	2,191,070	74,780	2,292,920	80,560
Minor apparatus:						
Flounders	5,000	125	3,500	125	8,500	250
Terrapin	450	105	3,520	1,379	3,970	1,484
Total	5,450	230	7,020	1,504	12,470	1,734
Grand total	991,855	23,943	3,159,790	104,994	4,151,645	128,937

THE WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Alabama centers at Mobile, this being the only city on the coast of the state. Shipments of products are received there, not only from localities in Alabama, but also from Mississippi. There are five wholesale fishery establishments, two of which handle both fish and oysters, two deal only in fish, and one only in oysters. The oysters are handled entirely in a raw condition, and the fish are sold fresh as received from the fishermen. Oysters are always sold by number, and are usually shipped in cedar buckets, not hermetically sealed, but are water-tight and holding about 2½, 4, and 8 gallons each. The number of oysters in a bucket is from 500 to 2,000, according to the kind of bucket and the size of the oysters. The

red snapper is the most important species of fish handled by these firms and is shipped over a considerable portion of the country. Among other important species handled are mullet, groupers, buffalo-fish, trout, channel bass or red-fish, Spanish mackerel, spots, sheeps-head, croakers, and flounders. The only wholesale fishery trade carried on outside of Mobile is at Coden and Bayou Labatre. In 1902 one firm handling opened oysters was located at Coden. At Bayou Labatre there was one oyster cannery, and four firms handling opened oysters, one of the latter also dealing in fresh fish. As there was only one oyster cannery in the state, the products are shown in the statistics as opened oysters, with the value received for them after being canned.

Table showing the extent of the wholesale fishery trade in Alabama in 1902.

Items.	Quantity.	Value.	Items.	Quantity.	Value.
Establishments	11	$134,350	*Products handled*—Cont'd.		
Cash capital		57,500			
Wages paid		68,300	King-fish ....lbs.	700	$25
Persons engaged	383		Lady-fish ....do.	600	12
			Mangrove snapper ....do.	200	8
Products handled.			Moon-fish ....do.	700	14
			Mullet ....do.	1,210,000	32,150
Oysters opened ....no.	[a]48,373,000	182,202	Pig-fish ....do.	15,400	334
Shrimp ....lbs.	40,000	3,200	Pike, or pickerel ....do.	850	55
Crabs ....no.	37,800	4,235	Pin-fish ....do.	19,100	644
Terrapin ....do.	3,500	1,425	Pompano ....do.	35,100	5,304
Turtles ....lbs.	6,800	286	Red snapper ....do.	3,600,000	165,350
Snapper throat ....do.	5,000	250	Sea bass ....do.	5,600	327
Black bass ....do.	8,800	857	Sheepshead ....do.	134,800	7,546
Blue-fish ....do.	41,000	2,035	Spade-fish ....do.	23,900	912
Bonito ....do.	1,100	35	Spanish mackerel ....do.	60,250	7,125
Buffalo-fish ....do.	233,100	6,403	Spots ....do.	89,500	3,934
Cat-fish ....do.	107,200	3,801	Strawberry bass ....do.	2,900	192
Channel bass or red-fish, pounds	123,000	6,620	Sturgeon ....do.	51,000	5,025
			Caviar ....do.	4,500	3,325
Crappie ....lbs.	2,600	173	Sun-fish ....do.	6,300	458
Crevalle ....do.	9,700	340	Trout, speckled ....do.	214,000	11,865
Croaker ....do.	75,700	3,230	Trout, white ....do.	45,500	1,940
Drum, fresh-water ....do.	5,100	191	Warmouth ....do.	4,900	346
Drum, salt-water ....do.	9,750	311	Whiting ....do.	21,800	596
Flounders ....do.	57,200	3,251	Yellow-tail ....do.	300	6
Groupers ....do.	744,200	22,250			
Jew-fish ....do.	2,000	40	Total value of product		488,640
Jurel ....do.	400	12			

[a] Includes the estimated number of oysters opened by the cannery at Bayou Labatre for canning purposes, and the value received when sold as canned goods.

FISHERIES OF MISSISSIPPI.

The coast line of Mississipi, including indentations, is about 180 miles in length and is well adapted for the prosecution of fishing. Of the three counties bordering on the Gulf of Mexico, Jackson, Harrison, and Hancock, Harrison has coast fisheries more than three times as important as those of the other two counties combined. Biloxi, a town of about 5,000 inhabitants, is located in this county and is the most important oyster center on the gulf coast. It is the leading town in the state in the catch of both oysters and shrimp, but is surpassed by Scranton, in Jackson County, in the catch of fish. Ocean Springs, also in Jackson County, ranks next to Biloxi in the quantity of fish caught. Of the other towns on the coast interested in the fisheries,

the most important are Bay St. Louis, in Hancock County, and Gulfport and Pass Christian, in Harrison County.

Markets.—The principal markets for the fishery products of Mississippi are New Orleans, La., Mobile, Ala., and the interior towns and cities of Mississippi and adjoining states, although canned oysters and shrimp are shipped throughout nearly the entire country. There are good shipping facilities at all the towns on the coast of Mississippi. At Biloxi fish are frequently landed by vessels from New Orleans and elsewhere, and are there iced and shipped to market. This is also done to some extent at Gulfport.

Rivers.—Mississippi has several rivers emptying into the Gulf of Mexico, the most important being the Pearl, Pascagoula, Jordan, and Wolf. The Pascagoula River, flowing through Jackson County, has the most extensive fisheries. The Wolf and Jordan rivers, in Harrison and Hancock counties, respectively, are frequented by fishermen from Bay St. Louis, the principal apparatus used being trammel nets.

Oysters.—The oyster fishery is by far the most important branch of fishing in the state, and is capable of much further development. Canneries and shucking houses are being built from year to year, thus increasing the demand for oysters. The increase in the number of shucking houses since 1897, the year for which the previous canvass of the state was made, has been greatest at Pass Christian.

In 1902 considerable change was made in the legislation regulating the oyster-fishery and oyster-canning industry. A law went into effect on June 1 of that year providing for a board of oyster commissioners, consisting of five members to be appointed by the governor, whose terms of office are for five years, the terms of the members first appointed being so arranged that thereafter a vacancy would occur and a new member be appointed each year. The officers of the board consist of a president, secretary, chief inspector, and deputy inspectors not exceeding three in nnmber.

The act also provides that the owner of any vessel over 1 ton burden gross desiring to catch oysters from the public reefs shall obtain a license therefor from the secretary of the board of oyster commissioners, and said license shall be in force twelve months from the first day of the month in which it is issued. The cost of each license is $2.50 for vessels over 1 ton and under 5 tons; $5 for vessels of 5 tons and under 10 tons; $10 for vessels of 10 tons and under 20 tons, and $15 for vessels of 20 or more tons. In addition to this a fee of 50 cents is charged for each license. No license is required for boats of 1 ton gross and under. Each canning factory is also required to pay a privilege tax of $100, and each shipper of raw oysters a tax of $25, after which they receive a license by paying an additional fee of 50 cents. They are also assessed 2 cents a barrel on all oysters canned or shipped in a raw condition. The money obtained from the payment

of these taxes, except the 50 cents for each license, is to be paid ove to the state treasurer, and constitutes an oyster fund. The expenses of enforcing the law are paid out of this fund, and a sum not exceeding $5,000 annually may be expended in improving the oyster reefs and in spreading shells and making new bottom, under the direction of the board of oyster commissioners.

All oysters taken from the public reefs of the state must be culled immediately on the natural beds or bars as taken, and all young oysters less than two and a half inches in length and all shells must be returned to the reefs. No cargo of oysters is allowed to contain more than 7 per cent of shells and small oysters. In order to determine whether or not a cargo has been properly culled, the inspector, if he deems it necessary, may cause every tenth barrel in the cargo to be culled. If the cargo on this basis proves to be unculled as required by law, he shall cause it to be reculled and the young oysters and shells returned to the reefs, and he shall prosecute the offender.

The chief inspector is authorized, between May 15 and September 1 in each year, under the direction of the board of commissioners, to employ boats, crews, and laborers, and dredge the oysters in Mississippi Sound from places where they are too thick and spread them on reefs where they are too thin, and to carry shells from the factories and spread them in places where the beds can be improved and enlarged.

The legal season for taking oysters in Mississippi waters is from September 15 to May 15, and oysters are not allowed to be shipped out of the state from May 1 to September 15. The law provides, however, that oysters may be taken during the entire year for local consumption. Oyster planters are also allowed to take oysters from the public reefs for planting in the waters of the state from May 15 to July 1, and oysters taken for planting purposes are not required to be culled.

Steam dredging for oysters, which began in 1897 in this state, was prohibited by the law passed in 1902, but there are no restrictions upon the use of dredges operated by sail vessels and boats. The section of the present law relating to the use of dredges is as follows:

Sec. 28. No steamer or other vessel using or propelled by steam or any other power than sail or hand, and no dredge, tongs, scoop, or other instrument or appliance of any character, propelled, managed, aided, used, or operated by means of steam or other power except hand and sail, shall be used or employed in catching or taking oysters in any of the waters of this State. This shall not prohibit the transportation by means of steam vessels of any oysters that have been lawfully caught.

The yield of oysters in Mississippi in 1902 was 2,405,132 bushels, valued at $426,222, an increase, as compared with the returns of 1897, of 1,775,419 bushels, or 281.94 per cent in quantity, and of $315,258, or 284.10 per cent in value. The catch would probably have been still larger, but the requirement, for the first time, of a license to

operate vessels and boats of over 1 ton gross in catching oysters caused considerable inconvenience to the oystermen for a while, and some of them neglected to obtain a license, and consequently did not engage in the fishery. The discontinuance of steam dredging, previously allowed in depths of 14 feet and over, was another change made by the new law which may have had an unfavorable effect on the catch. The dredging is now done by sail vessels in depths varying from about 4 to 21 feet. In 1902 a law was passed in Louisiana prohibiting the shipping of oysters out of the state for canning or packing. The influence of this law in curtailing the supply was felt by all of the packers in Mississippi, but especially by those in the western part of the state adjacent to Louisiana. Many of the oystermen, especially from Gulfport westward, tong in the waters of both Mississippi and Louisiana.

The oyster fishery in Mississippi is prosecuted in Mississippi Sound. The absence of oysters in the rivers may be due to the fact that, while the waters are brackish a distance of 5 to 10 miles up from the river mouths from June to November, they are practically fresh the remainder of the year.

Owing to the continued productiveness of the public reefs, and their close proximity to markets, there has so far been no great inducement to engage in oyster planting except in the case of cannery owners, who sometimes plant shells for collecting spat, and take up the resulting oysters when needed. No grounds are leased by the state for oyster cultivation, but the planting referred to is done on bottom made available by riparian rights.

Shrimp.—Next to the oyster the shrimp is the most important fishery product of the state. Most of the oyster vessels engage in taking shrimp in the spring and fall, April and May, and September and October being the seasons. In the spring the shrimp come in close to land and are caught in the small bayous which penetrate the marshes, the seines for taking them often being hauled upon the shore. They gradually work out into deeper water, and after the 1st of August are not seen until the fall season, when they are caught from 10 to 40 miles from shore. In the spring the catch is landed and sold at the canneries, but in the fall it is usually sold to transporting vessels, as the fishermen sometimes remain out a week at a time, or until their supply of ice is exhausted. The fall catch of shrimp is always much larger than the spring catch, due mainly to a longer season. Five men constitute the average crew of a shrimp vessel, though many carry only four. In hauling the seine two small rowboats, containing two men each, are used, the fifth man remaining on board of the vessel. The small boats are attached to the seine, one at each end, in order to surround the school of shrimp. In 1902 practically the entire catch of shrimp was used by the canning factories,

only a small quantity being shipped whole, as taken from the water. The catch of shrimp in this state in 1902 was 4,423,900 pounds, valued at $58,398, an increase, as compared with 1897, of 2,520,735 pounds and $29,594.

Trout.—Trout, or squeteague, rank next to shrimp in importance. They are taken very generally along the entire Gulf coast, trammel nets, seines, and lines being the principal apparatus of capture. Two species of squeteague are caught in Mississippi, known locally as "speckled trout" and "white trout," respectively. The former is a much firmer and better selling fish than the latter and largely predominates in the catch. The white trout is the species of squeteague so common along the Atlantic coast.

Mullet.—This is the most abundant species of fish taken in the shore fisheries of the Gulf coast. In Mississippi, however, its value is less than that of trout. Most of the catch in this state is taken in trammel nets, but a part is secured in cast nets. In some instances seines are successfully used, but this is only under certain conditions when the fish can not escape by jumping out of the net.

Croakers.—The catch of croakers is next to that of mullet in value. While not nearly so plentiful as mullet, the croaker sells much more readily, the market conditions in this section being quite different from those on the Atlantic coast, where there is at times no demand for this fish. It is caught principally on lines, though many are also taken in seines and trammel nets.

Channel bass or red-fish.—This is a widely distributed species and sells well. It is taken chiefly in trammel nets, but also in smaller quantities with seines and lines.

Sturgeon.—The capture of sturgeon in the fisheries of this state is of recent date, none being taken in any previous year for which statistics are available. The great scarcity of this species in the northern sections of the country is no doubt leading to the development of the fishery along the gulf coast. Sturgeon are quite plentiful in Mississippi waters, the Pascagoula River being especially well stocked with them. The fishery is now prosecuted for a distance of 60 miles up this river by the use of gasoline launches. In 1902 a sturgeon was caught measuring 8 feet 10 inches in length and 4 feet 8 inches in circumference. It is said that one measuring 14 feet in length was killed in the Pascagoula River by a tug boat, three or four years ago. Its weight was estimated between 500 and 600 pounds.

Black bass.—This species, as in other sections of the country, brings the fishermen a high price. It is very numerous in most of the rivers of Mississippi, though on account of the prohibition of the use of nets where it is most abundant, the quantities taken for market are not large.

Shad.—Shad are said to be taken regularly in the Pascagoula River about 10 miles from its mouth, but few, if any, reach the market, as

they are consumed locally by the fishermen. A plant of shad was made in this locality by the Fish Commission several years ago, but from some unknown cause the increase has not been as rapid as was expected. Some fishermen think better results might have been secured had the fish been planted about 30 miles from the mouth of the river, where the fry would have been safe from the predaceous salt-water species. A few shad were planted also in the Jordan River about the same time, but there is no record of more than an occasional capture.

Crabs.—Both hard and soft crabs are caught in this state, but the catch of the former is much the greater. Hard crabs are generally taken on trot lines baited with fresh meat, tripe, or the sinews of cattle. The season at Biloxi, where the largest catches are made, lasts about nine months of the year, the weather during the winter months, usually from December 15 to March 15, being too severe to permit of the fishery. In one locality a few hard crabs were taken with drop nets, an apparatus consisting of an iron hoop 2 feet in diameter with a shallow net attached. The net is baited with a piece of meat, and then dropped into the water by means of a line 10 or 15 feet long attached to the hoop. This, however, is rather a slow method of capture. Soft crabs are taken mostly by hand during the night, a lighted torch being used to find them. The fishing season is from May 15 to October 15. Until recently the crab catch has been used largely for local consumption, but a larger number of shipments is now being made.

Terrapin.—The greater part of the catch of this species credited to Mississippi is taken in the marshes of Louisiana. In most cases the fishermen secure the terrapin while fishing for oysters. Nippers are commonly used for catching them, but many are also taken by hand. At Biloxi, the center of the terrapin trade in Mississippi, there is a pound in which the animals are placed until they reach a marketable size, or are held for profitable prices.

Dredges and tongs.—These two kinds of apparatus are employed exclusively for taking oysters, and are used in both the shore and vessel fisheries. The use of dredges in Mississippi is comparatively recent, dating back only to 1897. As has already been stated, steam dredging was permitted until the season of 1902, when it was prohibited by the legislature.

Seines.—Two kinds of seines are used, one for catching shrimp and the other for catching fish. Shrimp seines average from 100 to 125 fathoms in length, an occasional one being 150 fathoms long. The size of the mesh is 1½ inches, stretched. The majority of the seines, both for shrimp and fish, widen toward the center, forming a pocket in which the catch settles when the ends of the seine are brought together. At Scranton, where fish seines are in more general use than

in any other locality in the state, they vary in width from 7 feet at the ends to 12 or 15 feet in the center, the latter forming a pocket about 12 feet deep. Shrimp seines are used chiefly on vessels, while most of the fish seines are used in the shore fisheries, except at Scranton, where they are used in both fisheries.

Trammel nets.—This apparatus is employed in both the shore and vessel fisheries, but mainly in the former. Scranton and Biloxi lead in the number of trammel nets. Those in common use at these places are about 5 feet deep, and are composed of three webs hung upon a single top and bottom line. The inside net is made of the best cotton, has a 2½-inch mesh stretched, and is hung slack. The two outside nets are hung straight, and have a 12-inch mesh, stretched. The top line usually has wooden corks or floats, and on the bottom line are leads placed about one foot apart, to keep the net in position. In this region the trammel net is operated by hauling it around the fish until they are forced into it. The use of this method of fishing is no doubt due to the presence of large schools of mullet, which can be taken more readily in trammel nets than in seines, because, owing to their propensity to jump, they can not readily be held in the latter. Often when a large school of fish is sighted, two trammel nets are fastened together, a man being stationed at each end of the net and another in the center where the two sections are joined.

Lines.—Lines are used exclusively in the shore fisheries. Many species are taken thus, but the most important are croakers, trout, and hard crabs.

Spears.—The use of spears is confined to the capture of flounders in the shore fisheries, and the fishing is usually done at night during June, July, and August, a flambeau or torch being used to furnish light.

Cast net.—This apparatus has become so common that it is nicknamed "life-preserver." Nearly every family living near the water possesses one. Its use for commercial fishing, however, is comparatively limited.

Gill nets.—The use of gill nets in 1902 was confined to the sturgeon of Jackson County, in the Pascagoula River. The average length of a sturgeon gill net was 200 yards, with a mesh 16 inches in length, stretched.

Persons employed.—The total number of persons engaged in the fisheries of this state in 1902 was 4,344. Of this number 826 were employed on fishing vessels; 70 on transporting vessels; 891 in the shore fisheries; and 2,557 as shoresmen, chiefly in the oyster and shrimp canneries. Compared with 1897 there was an increase of 1,779 persons, or 69.35 per cent. This was due largely to the development of the oyster fishery and the construction of new canneries.

Investment.—The total investment in the fisheries in this state in

1902 was $1,270,408, an increase as compared with the returns for 1897 of $752,107, or 145.11 per cent. Of the total investment, $160,200 represents the cash capital employed; $724,807 the amount invested in shore and accessory property; $280,650 the value of 179 fishing vessels and 13 transporting vessels, with their outfits; and $65,800 the value of 590 boats under 5 tons. The remainder represents the value of the fishing apparatus used.

Products.—The products of the fisheries of Mississippi in 1902 amounted to 23,426,965 pounds, having a value to the fishermen of $553,220, an increase since 1897 of 15,597,280 pounds, or 199.20 per cent, in quantity and $360,922, or 187.68 per cent, in value. This large increase was principally in oysters and shrimp.

The following tables present by counties the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of Mississippi in 1902:

Table showing, by counties, the number of persons employed in the fisheries of Mississippi in 1902.

Counties.	On vessels fishing.	On vessels transporting.	Boat or shore fishermen.	Shoresmen.	Total.
Jackson	70		183	153	406
Harrison	712	47	588	2,099	3,446
Hancock	44	23	120	305	492
Total	826	70	891	2,557	4,344

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Mississippi in 1902.

Items.	Jackson.		Harrison.		Hancock.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	18	$16,450	151	$143,550	10	$7,200	179	$167,200
Tonnage	146		1,631		75		1,852	
Outfit		4,345		39,430		2,655		46,430
Vessels transporting			9	47,400	4	16,500	13	63,900
Tonnage			180		118		298	
Outfit				2,195		925		3,120
Boats	186	10,635	347	47,455	57	7,710	590	65,800
Apparatus—vessel fisheries:								
Seines	12	1,065	66	7,095	2	200	80	8,360
Trammel nets	10	500					10	500
Dredges	20	620	270	8,110	8	220	298	8,950
Tongs	17	68	89	356	21	85	127	509
Minor apparatus			7	20			7	20
Apparatus—shore fisheries:								
Seines	13	1,075	52	5,120	1	50	66	6,245
Trammel nets	38	6,500	37	1,602	6	150	81	8,252
Gill nets	32	440					32	440
Cast nets	5	25	21	105	1	4	27	134
Lines		136		655		36		827
Dredges	52	210	90	2,310	2	40	144	2,560
Tongs	21	84	421	1,674	90	360	532	2,118
Minor apparatus		11		24		1		36
Shore and accessory property		22,175		629,275		73,357		724,807
Cash capital		22,000		128,200		10,000		160,200
Total		86,339		1,064,576		119,493		1,270,408

Table showing, by counties and species, the yield of the fisheries of Mississippi in 1902.

Species.	Jackson.		Harrison.		Hancock.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	14,460	$723	2,600	$141			17,060	$864
Blue-fish	11,645	313	50	3			11,695	316
Buffalo-fish	4,250	54	400	12			4,650	66
Cat-fish	31,500	578	30,900	689			62,400	1,267
Channel bass or red-fish	61,200	2,535	31,160	1,593	910	$39	93,270	4,167
Crappie	900	33	700	40	150	9	1,750	82
Croaker	44,600	822	216,100	7,010	12,300	741	273,000	8,573
Drum, salt-water	11,040	301	620	17			11,660	318
Flounders	32,400	1,373	46,460	1,822	600	30	79,460	3,225
Mullet, fresh	446,200	6,200	131,050	3,517	16,500	330	593,750	10,047
Mullet, salted			6,000	300			6,000	300
Pin-fish	6,000	148	600	18			6,600	166
Pompano	6,495	458	150	9			6,645	467
Sea bass	3,395	175	50	3			3,445	178
Sheepshead	55,450	2,285	14,240	647	535	32	70,225	2,964
Spade-fish	2,450	58					2,450	58
Spanish mackerel	6,755	356	500	29	200	30	7,455	415
Spot	31,400	538	44,900	1,423	1,200	60	77,500	2,021
Strawberry bass	900	33	700	40	150	9	1,750	82
Sturgeon	24,100	1,200					24,100	1,200
Caviar	414	310					414	310
Sun-fish	2,900	79	700	30	250	15	3,850	124
Trout	315,275	11,033	118,500	4,877	39,570	1,818	473,345	17,728
Warmouth	1,200	44	3,000	220	300	17	4,500	281
Whiting	20,450	493	31,660	687	1,200	72	53,310	1,252
Shrimp	590,900	8,257	3,768,000	48,766	65,000	1,375	4,423,900	58,398
Crab, hard	28,300	460	198,633	4,020	8,000	200	[a]234,933	4,680
Crab, soft			18,233	1,930	12,000	900	[b]30,233	2,830
Terrapin	4,500	1,537	7,191	3,082			[c]11,691	4,619
Oyster, natural	994,420	25,110	13,517,854	342,977	1,862,175	42,060	[d]16,374,449	410,147
Oyster, private	204,750	7,650	256,725	8,425			[e]461,475	16,075
Total	2,958,249	73,156	18,447,676	432,327	2,021,040	47,737	23,426,965	553,220

[a] 704,799 in number. [b] 90,699 in number. [c] 8,496 in number. [d] 2,339,207 in bushels. [e] 65,925 in bushels.

VESSEL AND SHORE FISHERIES.

The products of the vessel fisheries of Mississippi in 1902 amounted to 12,772,486 pounds, valued at $287,747. The catch with seines was 2,574,740 pounds of various species, valued at $35,663; with trammel nets, 165,150 pounds, valued at $3,678; with dredges and tongs, 10,030,125 pounds, or 1,432,875 bushels, of oysters, valued at $247,027; and with minor apparatus, 2,471 pounds of terrapin, valued at $1,379. In the shore fisheries the yield was 10,654,479 pounds, valued at $265,473. Seines took 2,113,790 pounds, $33,739; trammel nets, 884,530 pounds, $24,765; gill nets, 24,514 pounds, $1,510; cast nets, 93,010 pounds, $2,478; lines, 646,100 pounds, $17,393; spears, 46,000 pounds, $1,770; dredges and tongs, 6,805,799 pounds, or 972,257 bushels, of oysters, $179,195; and minor appliances, 40,736 pounds of crabs and terrapin, $4,623. The oysters were all from the public areas, except 65,925 bushels, valued at $16,075, taken in the shore fisheries.

The products of the vessel and shore fisheries are given separately by counties in the following tables:

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of Mississippi in 1902.

Apparatus and species.	Jackson.		Harrison.		Hancock.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Black bass	660	$33					660	$33
Blue-fish	670	21					670	21
Buffalo-fish	600	7					600	7
Cat-fish	1,600	32					1,600	32
Channel bass or red-fish	8,600	365					8,600	365
Croaker	6,800	132					6,800	132
Drum	1,340	31					1,340	31
Flounder	3,000	129					3,000	129
Mullet	2,700	49					2,700	49
Pompano	670	47					670	47
Sea bass	870	45					870	45
Sheepshead	7,200	297					7,200	297
Spade-fish	600	6					600	6
Spanish mackerel	680	34					680	34
Spot	4,900	90					4,900	90
Sun-fish	700	14					700	14
Trout	32,400	1,169					32,400	1,169
Whiting	2,600	57					2,600	57
Shrimp	304,900	4,107	2,131,800	$27,396	60,000	$1,200	2,496,700	32,703
Terrapin	1,450	402					1,450	402
Total	382,940	7,067	2,131,800	27,396	60,000	1,200	2,574,740	35,663
Trammel nets:								
Black bass	1,000	50					1,000	50
Blue-fish	1,900	47					1,900	47
Buffalo-fish	750	10					750	10
Cat-fish	2,950	53					2,950	53
Channel bass or red-fish	7,700	288					7,700	288
Croaker	4,400	73					4,400	73
Drum	1,600	43					1,600	43
Flounder	3,050	118					3,050	118
Mullet	85,500	1,070					85,500	1,070
Pompano	1,200	84					1,200	84
Sea bass	1,200	60					1,200	60
Sheepshead	6,900	264					6,900	264
Spade-fish	600	9					600	9
Spanish mackerel	1,200	60					1,200	60
Spot	3,250	49					3,250	49
Sun-fish	900	16					900	16
Trout	38,400	1,331					38,400	1,331
Whiting	2,650	53					2,650	53
Total	165,150	3,678					165,150	3,678
Dredges:								
Oyster, natural	508,725	13,570	7,862,330	190,443	443,800	10,400	8,814,855	214,413
Tongs:								
Oyster, natural	92,260	2,635	734,510	21,629	388,500	8,350	1,215,270	32,614
Minor apparatus:								
Terrapin			2,471	1,379			2,471	1,379
Grand total	1,149,075	26,950	10,731,111	240,847	892,300	19,950	12,772,486	287,747

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Mississippi in 1902.

Apparatus and species.	Jackson.		Harrison.		Hancock.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Black bass	2,000	$100	1,000	$45			3,000	$145
Blue-fish	825	24	50	3			875	27
Buffalo-fish	400	6					400	6
Cat-fish	1,150	23	200	7			1,350	30
Channel bass or red-fish	12,650	580	4,850	274	80	$6	17,580	860
Crappie	100	4	200	10			300	14
Croaker	8,550	223	17,200	605	300	21	26,050	849
Drum	1,100	26	120	3			1,220	29
Flounder	5,500	247	2,070	107			7,570	354
Mullet	9,500	156	2,650	86			12,150	242
Pin-fish	100	3	100	3			200	6
Pompano	775	56	50	3			825	59
Sea bass	275	17	50	3			325	20
Sheepshead	9,000	402	2,170	119			11,170	521
Spade-fish	100	2					100	2
Spanish mackerel	875	49	150	14			1,025	63
Spot	8,200	148	22,200	560	700	35	31,100	743
Strawberry bass	100	4	200	10			300	14
Sun-fish	200	8	200	10			400	18
Trout	29,250	1,132	21,700	1,218	500	35	51,450	2,385
Warmouth	100	4	500	30			600	34
Whiting	5,800	140	7,300	183			13,100	323
Shrimp	286,000	4,150	1,636,200	21,370	5,000	175	1,927,200	25,695
Crab, hard			1,800	45			1,800	45
Terrapin	2,400	855	1,300	400			3,700	1,255
Total	384,950	8,359	1,722,260	25,108	6,580	272	2,113,790	33,739
Trammel nets:								
Black bass	8,500	425	1,600	96			10,100	521
Blue-fish	8,250	221					8,250	221
Buffalo-fish	2,500	31	400	12			2,900	43
Cat-fish	9,400	142	1,100	42			10,500	184
Channel bass or red-fish	26,450	1,070	22,710	1,173	750	30	49,910	2,273
Crappie	300	12	500	30	100	6	900	48
Croaker	19,050	304	25,150	1,050	10,000	600	54,200	1,954
Drum	5,750	191	500	14			6,250	205
Flounder	14,800	607	3,790	189	300	15	18,890	811
Mullet	324,500	4,625	73,400	1,761	15,000	300	412,900	6,686
Pin-fish	5,900	145	500	15			6,400	160
Pompano	3,800	268	100	6			3,900	274
Sea bass	1,000	50					1,000	50
Sheepshead	26,500	1,088	2,970	162			29,470	1,250
Spade-fish	1,150	41					1,150	41
Spanish mackerel	3,800	203					3,800	203
Spot	14,700	247	18,800	698	500	25	34,000	970
Strawberry bass	300	12	500	30	100	6	900	48
Sun-fish	700	26	500	20	200	12	1,400	58
Trout	144,850	5,200	31,800	1,528	30,000	1,405	206,650	8,133
Warmouth	500	20	2,500	190	200	12	3,200	222
Whiting	8,800	231	9,060	179			17,860	410
Total	631,500	15,159	195,880	7,195	57,150	2,411	884,530	24,765
Gill nets:								
Sturgeon	24,100	1,200					24,100	1,200
Caviar	414	310					414	310
Total	24,514	1,510					24,514	1,510
Cast nets:								
Channel bass or red-fish					80	3	80	3
Crappie					50	3	50	3
Drum	50	2					50	2
Flounder			250	10			250	10
Mullet, fresh	24,000	300	55,000	1,670	1,500	30	80,500	2,000
Mullet, salted			6,000	300			6,000	300
Sheepshead	50	2	250	10	35	2	335	14
Spot	350	4	1,400	20			1,750	24
Strawberry bass					50	3	50	3
Sun-fish					50	3	50	3
Trout	375	18	1,250	62	70	3	1,695	78
Warmouth					100	5	100	5
Whiting	400	8	1,700	25			2,100	33
Total	25,225	329	65,850	2,097	1,935	52	93,010	2,478

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Mississippi in 1902—Continued.

Apparatus and species.	Jackson.		Harrison.		Hancock.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Lines:								
Black bass	2,300	$115					2,300	$115
Cat-fish	16,400	328	29,600	$640			46,000	968
Channel bass or red-fish	5,800	232	3,600	146			9,400	378
Crappie	500	17					500	17
Croaker	5,800	90	173,750	5,355	2,000	$120	181,550	5,565
Drum	1,200	8					1,200	8
Flounder	50	2	350	16	300	15	700	33
Pompano	50	3					50	3
Sea bass	50	3					50	3
Sheepshead	5,800	232	8,850	356	500	30	15,150	618
Spanish mackerel	200	10	350	15	200	30	750	55
Spot			2,500	145			2,500	145
Strawberry bass	500	17					500	17
Sun-fish	400	15					400	15
Trout	70,000	2,188	63,750	2,069	9,000	375	142,750	4,632
Warmouth	600	20					600	20
Whiting	200	4	13,600	300	1,200	72	15,000	376
Crab, hard	26,700	400	192,000	3,825	8,000	200	226,700	4,425
Total	136,550	3,684	488,350	12,867	21,200	842	646,100	17,393
Spears:								
Flounder	6,000	270	40,000	1,500			46,000	1,770
Dredges:								
Oyster, natural			1,279,600	31,050	45,500	975	1,325,100	32,025
Oyster, private			136,500	3,600			136,500	3,600
Total			1,416,100	34,650	45,500	975	1,461,600	35,625
Tongs:								
Oyster, natural	393,435	8,905	3,641,414	99,855	984,375	22,335	5,019,224	131,095
Oyster, private	204,750	7,650	120,225	4,825			324,975	12,475
Total	598,185	16,555	3,761,639	104,680	984,375	22,335	5,344,199	143,570
Minor apparatus:								
Crab, hard	1,600	60	4,833	150			6,433	210
Crab, soft			18,233	1,930	12,000	900	30,233	2,830
Terrapin	650	280	3,420	1,303			4,070	1,583
Total	2,250	340	26,486	3,383	12,000	900	40,736	4,623
Grand total	1,809,174	46,206	7,716,565	191,480	1,128,740	27,787	10,654,479	265,473

THE WHOLESALE FISHERY TRADE.

The wholesale trade in fishery products in Mississippi in 1902 was conducted by 28 establishments, including 9 oyster and shrimp canneries, 3 wholesale fish firms, and 16 shippers of opened oysters, shrimp, terrapin, and crabs. Opened oysters were also shipped by the canners and fish firms. The total number of persons employed in these establishments was 2,640; the amount of wages paid during the year was $245,950; the investment in shore and accessory property, $665,492; the cash capital utilized, $160,200, and the value of the products sold, $1,453,757.

At Biloxi, where the canning industry chiefly centers, there were 5 oyster and shrimp canneries, having a value, in shore and accessory property, of $389,120, and a cash capital of $44,000. The number of persons employed was 1,302, to whom $97,000 were paid in wages.

Most of the employees were Bohemians, who are brought from Baltimore each year and sent back at the close of the season. These canneries use the latest improved machinery, which reduces the number of persons needed to a minimum, most of those employed being engaged in unloading and shucking oysters. An establishment of average capacity can put up 42,000 cans by machinery in ten hours, which is equivalent to the labor of 30 men for the same length of time. Oysters are put up in 1 and 2 pound cans; dry and pickled shrimp in 1 and 1½ pound cans. Large quantities of shrimp are also put up in 1, 2, 3, 4, and 5 gallon cans, hermetically sealed, but not processed, as are the 1 and 1½ pound cans. By the use of preservaline the contents of these packages remain in good condition for several months. One of the canneries at Biloxi puts up hard crabs in 1 and 2 pound cans. This establishment also has a separate building with machinery for grinding oyster shells to different degrees of fineness according to the uses to be made of the product, the most common of which are for poultry food, concrete walks, imitation granite for fences, and fertilizer. Experiments are in progress with a view to finding additional uses for it. A large business is also conducted at Biloxi in shipping opened oysters in 2, 3, and 5 gallon buckets, holding from 500 to 1,250 oysters in number. Opened oysters are usually divided into four grades, namely, "plants," "extra selects," "selects," and "reefers."

The remainder of the canneries in the state, 1 at Bay St. Louis, 1 at Pass Christian, 1 at Gulfport, and one at Scranton, represented in 1902 an investment of $311,047 in shore and accessory property, and of $95,000 in cash capital. The number of persons employed was 950, most of whom, as at Biloxi, were Bohemians. The amount of wages paid during the year was $62,800. Oysters were canned in all of these canneries, and shrimp in all except the one at Scranton, which was started too late in the fall for the latter product.

The three firms handling fish at wholesale are located at Scranton. The quantity of products sold in 1902 was 790,800 pounds, having a value of $34,259. The fish are shipped to Mobile, Ala., and other cities in this region.

The following table gives the extent of the wholesale trade in fishery products in Mississippi in 1902:

Table showing the extent of the canning industry and wholesale trade in fishery products in Mississippi in 1902.

Items.	Bay St. Louis, Pass Christian, and Gulf Port.		Biloxi.		Scranton and Ocean Springs.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	11	$248,237	10	$397,275	7	$19,980	28	$665,492
Cash capital		87,600		50,600		22,000		160,200
Wages paid		70,250		124,300		16,600		211,150
Persons engaged	1,076		1,411		153		2,640	
Products received:								
Oysters ....bbls.	347,688	190,972	524,850	213,750	28,300	20,765	900,838	425,487
Shrimp ....do.	12,103	31,258	15,400	60,100	150	525	27,653	91,883
Crabs ....no.			a 273,420	1,139	128,600	350	402,020	1,489
Terrapin ....do.			7,234	4,115			7,234	4,115
Fish ....lbs.					876,000	21,900	876,000	21,900
Products as sold:								
Oysters—								
Opened, plants ....no.	1,926,000	10,579	5,600,000	38,731	1,605,000	11,480	9,131,000	60,790
Opened, extra selects, number	2,084,000	7,293	7,362,500	29,235	1,025,000	3,845	10,471,500	40,373
Opened, selects ....no.	6,453,500	19,910	21,625,000	73,685	7,700,000	26,640	35,778,500	120,235
Opened, reefers ....do.	2,426,500	5,980	2,662,500	5,325	2,080,000	5,200	7,169,000	16,505
Canned, 1-lb. cans ...do.	2,728,000	171,380	5,369,397	300,404	61,765	3,603	8,159,162	475,387
Canned, 2-lb. cans ...do.	999,000	122,325	3,141,362	337,459	18,530	1,930	4,158,892	461,714
Shells ....bbls.	551,114	6,022	150,000	2,000			701,114	8,022
Shrimp—								
Whole ....do.					150	675	150	675
Headless ....gals.	28,250	13,277	40,413	18,324			68,663	31,601
Peeled ....do.	2,275	1,500	2,355	1,534			4,630	3,034
Canned, 1-lb. cans, dry, number	428,500	28,455	222,292	14,340			650,792	42,795
Canned, $1\frac{1}{2}$-lb. cans, dry, number	331,000	45,530	319,989	41,495			650,989	87,025
Canned, 1-lb. cans, pickled, number	20,000	1,410	761,876	49,490			781,876	50,900
Canned, $1\frac{1}{2}$-lb. cans, pickled ....no.			63,033	8,404			63,033	8,404
Crabs, whole ....do.					106,900	555	106,900	555
Terrapin ....do.			7,234	11,483			7,234	11,483
Fish—								
Black bass ....lbs.					12,000	840	12,000	840
Blue-fish ....do.					11,000	495	11,000	495
Buffalo-fish ....do.					3,000	90	3,000	90
Cat-fish ....do.					16,000	610	16,000	610
Channel bass or red-fish, pounds					45,000	2,475	45,000	2,475
Croakers ....lbs.					26,500	965	26,500	965
Drum ....do.					7,000	330	7,000	330
Flounders ....do.					13,000	780	13,000	780
Mullet ....do.					320,000	8,800	320,000	8,800
Pompano ....do.					4,500	405	4,500	405
Sea bass ....do.					2,500	170	2,500	170
Sheepshead ....do.					31,000	1,860	31,000	1,860
Spade-fish ....do.					500	16	500	16
Spanish mackerel ...do.					4,500	355	4,500	355
Spots					12,000	420	12,000	420
Sturgeon					4,500	250	4,500	250
Sun-fish					5,800	308	5,800	308
Trout, speckled					215,000	12,900	215,000	12,900
Trout, white					49,000	1,860	49,000	1,860
Whiting					8,000	330	8,000	330
Value of products sold		433,661		931,909		88,187		1,453,757

a These crabs were put up in 1 and 2 pound cans. As there was only one firm at Biloxi engaged in canning crabs, the quantity and value of the canned product are omitted from the table.

FISHERIES OF LOUISIANA.

The returns for the fisheries of Louisiana in 1902 compare favorably with those of any previous year. In respect to number of persons employed in fishing, the returns differ little from those for 1897 or for 1890, but the number of shoresmen has increased considerably owing to the establishment of new canneries and oyster-shucking houses. For the same reason the investment in the fishery industries shows an increase. The total value of the product, $858,314, is larger than that of any other year for which there are complete returns. In 1897 it was $713,587; in 1890, $681,284, and in 1880, $392,610. This increase has been contributed by nearly every branch of the fisheries.

The oyster industry, the most important branch of the fisheries of this state as well as of the United States, shows a larger yield than in 1897, increasing from 959,190 bushels, worth $432,668, to 1,198,413 bushels, worth $493,227. In 1890 it was only 440,800 bushels, worth $127,990. The growth of this industry is due to an increased demand rather than to a greater abundance on the reefs. The cultivation of oysters is attracting much attention in Louisiana, and well-directed efforts are now being made to develop profitable use of the grounds at present unproductive.

The seine fishery shows a very large increase since 1897, especially in the product, increasing from 6,554,749 pounds, worth $173,454, to 12,565,415 pounds, worth $251,826. The yield of shrimp contributed the bulk of this, the catch being 7,589,220 pounds, worth $130,560, whereas in 1897 it was only 4,402,626 pounds, worth $78,792. The catch of buffalo-fish is also much larger, being 2,671,860 pounds in 1902 as against 147,200 pounds in 1897. The trout yield has more than doubled, increasing from 498,783 pounds in 1897 to 1,057,840 pounds in 1902. Channel bass and sheepshead, which come next in importance, show little change in either quantity or value. The quantity of Spanish mackerel is less. In 1897, 50,505 pounds of this species was taken by seines, whereas in 1902 the catch was only 5,500 pounds.

The increase in the catch by lines has been very much less than in either the seine fishery or the oyster industry. Indeed there has been a small decrease in the weight of the line catch since 1897, from 3,149,724 to 3,096,665 pounds, but this is offset by an increase in the value from $63,935 to $77,454, due principally to the enhanced price per pound of the catfish taken at Morgan City and Melville.

The yield of alligator hides shows a slight decrease in number since 1897, from 41,092, worth $22,096, to 38,968, worth $23,132. The number reported in 1889 was 74,240, worth $38,185. The average length of the hides has greatly decreased, a large percentage of those taken at present measuring 3 feet and under, whereas the taking of

such as these was unusual six years ago. Hides of more than 5 feet in length are now quite scarce.

The number of crabs taken has decreased from 4,376,500 in 1897 to 3,936,405 in 1902, but the value has increased from $12,891 to $16,025. The catch consists principally of hard crabs taken in Jefferson, Orleans, and St. Bernard parishes. In the vicinity of New Orleans a few soft crabs are taken, but not by any means so many as the conditions seem to warrant.

The following series of tables shows the number of persons employed in the fisheries of Louisiana in 1902; the number and value of vessels, boats, and apparatus used; the amount of capital invested, and the quantity and value of the products.

Persons employed.

How engaged.	No.
On vessels fishing	109
On vessels transporting	87
In shore or boat fisheries	3,570
Shoresmen	1,261
Total	5,027

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	35	$17,795	Apparatus—shore fisheries:		
Tonnage	217		Seines	146	$17,798
Outfit		7,615	Fyke nets	114	606
Vessels transporting	42	21,800	Minor nets	2,400	610
Tonnage	251		Lines		6,253
Outfit		5,920	Tongs	1,781	8,881
Boats	2,968	240,203	Shore and accessory property		333,935
Apparatus—vessel fisheries:			Cash capital		126,950
Seines	9	990			
Lines		30	Total		789,723
Tongs	67	337			

Table of products.

Species.	Lbs.	Value.	Species.	Lbs.	Value.
Black bass	18,940	$1,328	Spanish mackerel	6,050	$607
Blue-fish	100	6	Sun-fish	7,900	246
Buffalo-fish	2,887,860	23,919	Trout	1,078,240	49,071
Cat-fish	2,051,365	63,024	Yellow-tail	6,120	245
Channel bass	441,595	19,961	Miscellaneous fish	31,400	1,164
Crevalle	3,160	113	Oyster	[a] 8,388,891	493,227
Croaker	154,860	7,188	Shrimp	7,631,720	131,715
Drum, fresh-water	3,500	35	Crab, hard	[b] 1,312,135	16,025
Drum, salt-water	51,280	1,302	Crawfish	16,000	615
Flounder	2,100	129	Terrapin	30,589	6,439
Mullet	122,710	3,884	Turtle	5,140	199
Pompano	3,230	350	Alligator hides	[c] 194,840	23,132
Sheepshead	238,560	11,381			
Silver-perch	62,850	3,009	Total	24,754,135	858,314

[a] 1,198,413 bushels. [b] 3,936,405 in number. [c] 38,968 in number.

STATISTICS BY COUNTIES.

In Louisiana there are twenty-one counties, or parishes, in which coast fisheries of commercial importance are prosecuted. The more important of these are Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Landry, St. Mary, and Terrebonne.

Following are three tables giving the extent of the fisheries, by counties:

Table showing, by counties, the number of persons employed in the fisheries of Louisiana in 1902.

Parish or county.	On vessels fishing.	On vessels transporting.	Shore or boat fishermen.	Shoresmen.	Total.
Calcasieu			12		12
Cameron			37		37
Jefferson			521	62	583
Lafourche	2	2	369		373
Orleans	29	2	440	819	1,290
Plaquemines	8	4	630	104	746
St. Bernard			138		138
St. Charles			12		12
St. John the Baptist			4		4
St. Landry [a]			184		184
St. Mary [b]	62	39	671	157	929
St. Tammany			24		24
Tangipahoa			16		16
Terrebonne	8	32	470	119	629
Vermilion		8	42		50
Total	109	87	3,570	1,261	5,027

[a] Includes the parishes of Pointe Coupee, Iberville, Avoyelles, and a portion of St. Martin.
[b] Includes the parishes of Assumption, Iberia, and portions of Iberville and St. Martin.

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Louisiana in 1902.

Items.	Calcasieu.		Cameron.		Jefferson.		Lafourche.		Orleans.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing							1	$400	6	$5,650
Tonnage							5		42	
Outfit								120		2,175
Vessels transporting							1	500	1	500
Tonnage							5		7	
Outfit								100		100
Boats	12	$215	36	$792	179	$34,285	226	20,710	362	36,155
Apparatus—vessel fisheries:										
Seines									1	240
Tongs							2	11	21	105
Apparatus—shore fisheries:										
Seines			5	490	46	9,715	12	1,935	41	2,320
Fyke nets	12	96								
Minor nets									2,200	550
Lines		80		50		645				130
Tongs			20	100	40	196	265	1,325	180	900
Shore and accessory property		200		400		36,510		4,100		187,000
Cash capital						13,700				66,000
Total		591		1,832		95,051		29,201		301,825

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Louisiana in 1902—Continued.

Items.	Plaquemines.		St. Bernard.		St. John Baptist.		St. Charles.		St. Landry.		St. Mary.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	2	$1,600									23	$8,845
Tonnage	14										139	
Outfit		590										4,293
Vessels transporting	2	1,110									18	11,870
Tonnage	14										107	
Outfit		160										3,810
Boats	797	86,233	82	$2,935	2	$150	5	$500	188	$2,878	632	21,252
Apparatus—vessel fisheries:												
Seines											7	650
Lines												30
Tongs	8	41									32	160
Apparatus—shore fisheries:												
Seines			21	2,018	1	100	3	360			4	220
Fyke nets									102	510		
Minor nets	200	60										
Lines		70		96						836		4,250
Tongs	615	3,075	2	10							192	960
Shore and accessory property		62,400		1,000		40		150		3,500		20,995
Cash capital		15,000										20,500
Total		170,339		6,059		290		1,010		7,724		97,835

Items.	St. Tammany.		Tangipahoa.		Terrebonne.		Vermilion.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing					3	$1,300			35	$17,795
Tonnage					17				217	
Outfit						437				7,615
Vessels transporting					16	6,270	4	$1,550	42	21,800
Tonnage					95		23		251	
Outfit						1,510		240		5,920
Boats	23	$900	14	$320	382	29,978	28	2,900	2,968	240,203
Apparatus—vessel fisheries:										
Seines					1	100			9	990
Lines										30
Tongs					4	20			67	337
Apparatus—shore fisheries:										
Seines	4	200	1	50	5	390			146	17,798
Fyke nets									114	606
Minor nets									2,400	610
Lines		40		18				38		6,253
Tongs					430	2,150	33	165	1,781	8,881
Shore and accessory property		100		100		17,050		390		333,935
Cash capital						11,750				126,950
Total		1,240		488		70,955		5,283		789,723

Table showing, by counties and species, the yield of the fisheries of Louisiana in 1902.

Species.	Calcasieu.		Cameron.		Jefferson.		Lafourche.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Buffalo-fish	19,500	$510	4,000	$60	1,426,200	$10,696	416,500	$3,330
Cat-fish	12,000	575	35,200	1,055	121,970	2,360	17,250	517
Channel bass			500	25	120,500	4,960	16,240	812
Croaker			400	20	43,200	1,606	7,850	294
Drum, salt-water					22,000	410		
Flounder			800	48				
Mullet			1,000	20	26,500	485	16,000	480
Pompano					1,500	150	300	36
Sheepshead			10,000	300	92,600	4,640	12,500	625
Spanish mackerel					2,250	225	600	60
Trout			14,300	846	663,950	27,990	55,300	2,765
Miscellaneous fish					24,000	700		
Oyster			16,800	600	134,400	9,985	1,176,315	55,700
Shrimp			900	54	6,551,470	107,965	885,700	19,410
Crab					919,067	10,655		
Terrapin			4,000	120	4,214	1,187	2,250	285
Turtle			2,000	50	1,200	24		
Alligator					31,200	3,846	34,350	4,180
Total	31,500	1,085	89,900	3,198	10,186,221	187,884	2,641,155	88,494

Table showing, by counties and species, the yield of the fisheries of Louisiana in 1902— Continued.

Species.	Orleans.		Plaquemines.		St. Bernard.		St. Charles.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	80	$8			18,860	$1,320		
Blue-fish	100	6						
Buffalo-fish	40,160	853	6,000	$110	5,000	100	612,000	$4,590
Cat-fish	20,220	1,116	85,100	1,702	28,980	797	15,000	450
Channel bass	160,205	8,021			52,800	2,640		
Crevalle	3,160	113						
Croaker	56,250	3,096	3,000	120	15,000	600		
Drum, salt-water	3,480	139			18,500	600		
Flounder	300	21			1,000	60		
Mullet	67,160	2,601			3,400	85		
Pompano	960	115			200	20		
Sheepshead	16,050	1,063	800	48	35,710	2,010		
Silver perch	700	29			62,150	2,980		
Spanish mackerel	1,320	132			800	80		
Sun-fish	3,200	128			4,400	110		
Trout	55,300	3,433	2,000	100	173,640	9,584		
Yellow-tail	6,120	245						
Miscellaneous fish	6,500	410			900	54		
Oyster	1,250,550	58,710	2,539,614	205,616	8,400	490		
Shrimp	17,500	525	28,000	630	17,000	380		
Crab	303,335	3,870			79,733	1,340		
Crawfish	16,000	615						
Terrapin	720	140	600	120	4,120	760		
Turtle					1,440	115	500	10
Total	2,029,370	85,389	2,665,114	208,446	532,033	24,125	627,500	5,050

Species.	St. John Baptist.		St. Landry.		St. Mary.		St. Tammany.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Buffalo-fish	150,000	$1,125	93,500	$935	92,000	$1,150	7,500	$160
Cat-fish			254,560	8,207	1,425,185	44,819	16,400	676
Channel bass					52,900	2,116	4,150	290
Croaker					6,510	246	14,250	870
Drum, fresh-water			3,500	35				
Drum, salt-water					5,500	122		
Mullet					5,150	103	2,000	80
Pompano					50	6		
Sheepshead					45,700	1,828	1,000	70
Spanish mackerel					730	75		
Sun-fish					300	8		
Trout					68,400	2,738	3,850	262
Oyster					951,342	47,308		
Shrimp					72,850	1,556		
Crab							10,000	160
Terrapin					7,500	2,250		
Alligator			47,000	5,620	56,090	6,566		
Total	150,000	1,125	398,560	14,797	2,790,207	110,891	59,150	2,568

Species.	Tangipahoa.		Terrebonne.		Vermilion.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass							18,940	$1,328
Blue-fish							100	6
Buffalo-fish	5,500	$105	5,000	$70	5,000	$125	2,887,860	23,919
Cat-fish	10,500	390			9,000	360	2,051,365	63,024
Channel bass			34,300	1,097			441,595	19,961
Crevalle							3,160	113
Croaker	5,000	240	3,400	96			154,860	7,188
Drum, fresh-water							3,500	35
Drum, salt-water			1,800	31			51,280	1,302
Flounder							2,100	129
Mullet			1,500	30			122,710	3,884
Pompano			220	23			3,230	350
Sheepshead	700	47	23,500	750			238,560	11,381
Silver perch							62,850	3,009
Spanish mackerel			350	35			6,050	607
Sun-fish							7,900	246
Trout	1,150	69	40,350	1,284			1,078,240	49,071
Yellow-tail							6,120	245
Miscellaneous fish							31,400	1,164
Oyster			2,182,110	108,658	129,360	6,160	8,388,891	493,227
Shrimp			61,300	1,195			7,634,720	131,715
Crab							1,312,135	16,025
Crawfish							16,000	615
Terrapin			7,185	1,577			30,589	6,439
Turtle							5,140	199
Alligator			21,300	2,430	4,900	490	194,840	23,132
Total	22,850	851	2,382,315	117,276	148,260	7,135	24,754,135	858,314

THE PRODUCTS BY APPARATUS.

The yield of the vessel fisheries of Louisiana, including all species, was 653,845 pounds, valued at $27,000, and of the shore fisheries, 24,100,290 pounds, valued at $831,314. The principal kinds of fishing apparatus employed on vessels and boats were seines, fyke nets, lines, and oyster tongs. Considerable quantities of products were also taken with various other appliances.

The following tables give, by counties and species, the quantity and value of the catch taken with each form of apparatus in the vessel and shore fisheries:

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of Louisiana in 1902.

Apparatus and species.	Lafourche.		Orleans.		Plaquemines.		St. Mary.		Terrebonne.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Value.	Lbs.	Val.	Lbs.	Val.
Seines:												
Buffalo-fish			860	$17							860	$17
Cat-fish			1,120	51			19,000	$472			20,120	523
Channel bass			28,285	1,215			38,400	1,536	2,800	$112	69,485	2,863
Crevalle			1,360	75							1,360	75
Croaker			2,040	123			4,710	174	400	16	7,150	313
Drum, salt water			580	23			4,500	102	300	6	5,380	131
Flounders			50	4							50	4
Mullet			3,560	107			3,950	79	300	6	7,810	192
Pompano			160	19					20	3	180	22
Sheepshead			1,500	90			34,200	1,368	2,000	80	37,700	1,538
Silver perch			100	5							100	5
Spanish mackerel			220	22			530	55	100	10	850	87
Sun-fish							200	4			200	4
Trout			7,300	438			50,400	2,018	3,600	144	61,300	2,600
Yellow-tail			1,000	40							1,000	40
Shrimp							40,850	886	16,000	320	56,850	1,206
Terrapin			120	20							120	20
Total			48,255	2,249			196,740	6,694	25,520	697	270,515	9,640
Lines:												
Cat-fish							43,060	1,435			43,060	1,435
Tongs:												
Oyster	10,500	$525	157,150	6,950	57,750	$2,720	99,120	4,935	15,750	795	340,270	15,925
Grand total	10,500	525	205,405	9,199	57,750	2,720	338,920	13,064	41,270	1,492	653,845	27,000

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Louisiana in 1902.

Apparatus and species.	Calcasieu.		Cameron.		Jefferson.		Lafourche.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Buffalo-fish			4,000	$60	1,426,200	$10,696	416,500	$3,330
Cat-fish			3,500	105	38,400	115	17,250	517
Channel bass or red-fish			500	25	120,500	4,960	16,240	812
Croaker			400	20	42,800	1,590	7,850	294
Drum, salt water					22,000	410		
Flounder			800	48				
Mullet			1,000	20	26,500	485	16,000	480
Pompano					1,500	150	300	36
Sheepshead			10,000	300	92,600	4,640	12,500	625
Spanish mackerel					2,000	200	600	60
Trout			14,300	816	660,450	27,815	55,300	2,765
Other fish					22,000	600		
Shrimp			900	54	6,551,470	107,965	885,700	19,410
Terrapin			4,000	120				
Turtle					1,200	21		
Total			39,400	1,598	9,007,620	159,650	1,428,240	28,329

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Louisiana in 1902—Continued.

Apparatus and species.	Calcasieu.		Cameron.		Jefferson.		Lafourche.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fyke nets:								
Buffalo-fish	7,500	$210						
Cat-fish	2,500	125						
Total	10,000	335						
Lines:								
Buffalo-fish	12,000	300						
Cat-fish	9,500	450	31,700	950	83,570	2,245		
Croaker					400	16		
Spanish mackerel					250	25		
Trout					3,500	175		
Other fish					2,000	100		
Crab					919,067	10,655		
Turtle			2,000	50				
Total	21,500	750	33,700	1,000	1,008,787	13,216		
Minor apparatus:								
Terrapin					4,214	1,187	2,250	285
Alligator hides					31,200	3,846	34,350	4,180
Total					35,414	5,033	36,600	4,465
Tongs:								
Oyster			16,800	600	134,400	9,985	1,165,815	55,175
Grand total	31,500	1,085	89,900	3,198	10,186,221	187,884	2,630,655	87,969

Apparatus and species.	Orleans.		Plaquemines.		St. Bernard.		St. Charles.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Black bass	80	$8			18,860	$1,320		
Blue-fish	100	6						
Buffalo-fish	39,300	836			5,000	100	612,000	$4,590
Cat-fish	9,600	495			20,480	542	15,000	450
Channel bass or red-fish	130,420	6,701			52,800	2,640		
Crevalle	1,800	38						
Croaker	26,210	1,533			13,000	520		
Drum, salt-water	2,900	116			18,500	600		
Flounder	250	17			1,000	60		
Mullet	62,800	2,454			3,400	85		
Pompano	800	96			200	20		
Sheepshead	10,550	693			33,210	1,860		
Silver perch	600	24			62,150	2,980		
Spanish mackerel	1,100	110			500	50		
Sun-fish	3,200	128			4,400	110		
Trout	41,500	2,540			169,240	9,320		
Yellow-tail	5,120	205						
Other fish	4,500	290			300	18		
Shrimp					17,000	380		
Terrapin	600	120			4,120	760		
Turtle					1,440	115	500	10
Total	341,430	16,410			425,600	21,480	627,500	5,050
Lines:								
Cat fish	9,500	570	83,600	$1,672	8,500	255		
Channel bass or red-fish	1,500	105						
Croaker	28,000	1,440	3,000	120	2,000	80		
Mullet	800	40						
Sheepshead	4,000	280	800	48	2,500	150		
Spanish mackerel					300	30		
Trout	6,500	455	2,000	100	4,400	264		
Other fish	2,000	120			600	36		
Crab					79,733	1,340		
Total	52,300	3,010	89,400	1,940	98,033	2,155		
Minor apparatus:								
Buffalo-fish			6,000	110				
Cat-fish			1,500	30				
Shrimp	17,500	525	28,000	630				
Crab	303,335	3,870						
Crawfish	16,000	615						
Terrapin			600	120				
Total	336,835	5,010	36,100	890				
Tongs:								
Oyster	1,093,400	51,760	2,481,864	202,896	8,400	490		
Grand total	1,823,965	76,190	2,607,364	205,726	532,033	24,125	627,500	5,050

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Louisiana in 1902—Continued.

Apparatus and species.	St. John Baptist.		St. Landry.		St. Mary.		St. Tammany.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Buffalo-fish	150,000	$1,125					7,500	$160
Cat-fish					6,500	$145	6,400	276
Channel bass or red-fish					14,500	580	4,150	290
Croaker					1,800	72	8,250	510
Drum, salt-water					1,000	20		
Mullet					1,200	24	2,000	80
Pompano					50	6		
Sheepshead					11,500	460	1,000	70
Spanish mackerel					200	20		
Sun-fish					100	4		
Trout					18,000	720	850	52
Shrimp					32,000	670		
Total	150,000	1,125			86,850	2,721	30,150	1,438
Fyke nets:								
Buffalo-fish			93,500	$935				
Cat-fish			7,800	266				
Drum, fresh-water			3,500	35				
Total			104,800	1,236				
Lines:								
Buffalo-fish					92,000	1,150		
Cat-fish			246,760	7,941	1,356,625	42,767	10,000	400
Croaker							6,000	360
Trout							3,000	210
Crab							10,000	160
Total			246,760	7,941	1,448,625	43,917	29,000	1,130
Minor apparatus:								
Terrapin					7,500	2,250		
Alligator hides			47,000	5,620	56,090	6,566		
Total			47,000	5,620	63,590	8,816		
Tongs:								
Oyster					852,222	42,373		
Grand total	150,000	1,125	398,560	14,797	2,451,287	97,827	59,150	2,568

Apparatus and species.	Tangipahoa.		Terrebonne.		Vermilion.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Black bass							18,940	$1,328
Blue-fish							100	6
Buffalo-fish	5,500	$105	5,000	$70			2,671,000	21,072
Cat-fish	2,500	110					119,630	2,755
Channel bass or red-fish			31,500	985			370,610	16,993
Crevalle							1,800	38
Croaker	3,000	140	3,000	80			106,310	4,759
Drum, salt-water			1,500	25			45,900	1,171
Flounder							2,050	125
Mullet			1,200	24			114,100	3,652
Pompano			200	20			3,050	328
Sheepshead	200	12	21,560	670			193,060	9,330
Silver perch							62,750	3,004
Spanish mackerel			250	25			4,650	465
Sun-fish							7,700	242
Trout	150	9	36,750	1,140			996,540	45,207
Yellow-tail							5,120	205
Other fish							26,800	908
Shrimp			45,300	875			7,532,370	129,354
Terrapin			560	95			9,280	1,095
Turtle							3,140	149
Total	11,350	376	146,760	4,009			12,294,900	242,186
Fyke nets:								
Buffalo-fish							101,000	1,145
Cat-fish							10,300	391
Drum, fresh-water							3,500	35
Total							114,800	1,571

Table showing, by counties, apparatus, and species, the yield of the shore fisheries of Louisiana in 1902—Continued.

Apparatus and species.	Tangipahoa.		Terrebonne.		Vermilion.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Lines:								
Buffalo-fish					5,000	$125	109,000	$1,575
Cat-fish	8,000	$280			9,000	360	1,856,755	57,890
Channel bass or red-fish							1,500	105
Croaker	2,000	100					41,400	2,116
Mullet							800	40
Sheepshead	500	35					7,800	513
Spanish mackerel							550	55
Trout	1,000	60					20,400	1,264
Other fish							4,600	256
Crab							1,008,800	12,155
Turtle							2,000	50
Total	11,500	475			14,000	485	3,053,605	76,019
Minor apparatus:								
Buffalo-fish							6,000	110
Cat-fish							1,500	30
Shrimp							45,500	1,155
Crab							303,335	3,870
Crawfish							16,000	615
Terrapin			6,625	$1,482			21,189	5,324
Alligator hides			21,300	2,430	4,900	490	191,840	23,132
Total			27,925	3,912	4,900	490	588,364	34,236
Tongs:								
Oyster			2,166,360	107,863	129,360	6,160	8,048,621	477,302
Grand total	22,850	851	2,341,045	115,784	148,260	7,135	24,100,290	831,314

Table showing the wholesale trade in fishery products for Louisiana in 1902.

Items.	Morgan City.	Houma.	Barataria section.	New Orleans and elsewhere.	Total.
Establishments	6	6	6	8	26
Value	$13,975	$13,050	$30,710	$230,800	$288,535
Cash capital	$20,500	$11,750	$13,700	$81,000	$126,950
Employees	157	119	62	923	1,262
Products received:					
Oysters ...bushels	19,220			178,750	197,950
Value	$4,830			$49,500	$54,330
Shrimp ...pounds	56,000		3,389,450	3,695,787	7,141,237
Value	$1,120		$29,131	$72,230	$102,481
Fish ...pounds			191,250		191,250
Value			$2,677		$2,677
Products as sold:					
Oysters, canned—					
1-pound cans ...number	128,920			975,000	1,103,920
Value	$8,379			$75,312	$83,691
2 pound cans ...number				325,000	325,000
Value				$39,687	$39,687
Shrimp, canned—					
1-pound cans, dry ...number	62,200			829,648	891,848
Value	$4,043			$58,600	$62,643
1-pound cans, wet ...number				875,864	875,864
Value				$61,846	$61,846
2-pound cans, dry ...number				1,005,352	1,005,352
Value				$142,091	$142,091
2-pound-cans, wet ...number				28,824	28,824
Value				$4,083	$4,083
Shrimp, dried ...pounds				371,350	371,350
Value				$51,603	$51,603
Shrimp, shells, dried ...pounds				24,000	24,000
Value				$60	$60
Fish, dried ...pounds				95,750	95,750
Value				$6,222	$6,222

NOTE.—The above does not include the fresh fish, shrimp, and oysters handled in the wholesale trade, but only the canned and dried products prepared.

FISHERIES OF TEXAS.

Considering the great length of the coast line of Texas and the area of the coastal waters, the fisheries of this state are of relatively small extent. This is due principally to the remoteness of markets and the generally undeveloped industrial condition of the coast sections.

There are three principal fisheries in the state, namely, the bay-seine fishery, yielding $129,667 worth of products in 1902; the red snapper fishery, yielding $106,400, and the oyster fishery, valued at $100,359. The remaining $17,388 worth of products consisted of flounders taken by spears, $5,726; fish, taken by lines, $4,862; green turtle, taken by nets, $2,618; fish and shrimp, taken by cast nets, $2,160, and hard crabs, $2,022.

Compared with 1897, the seine fishery shows a slight decrease. The number of seines used in that year was 171, with a value of $18,279, whereas in 1902 it was 166, with a value of $16,735. The decrease in yield was slightly greater, namely, from 3,561,035 pounds, selling for $153,070, to 3,049,860 pounds, worth $129,667. The largest decrease has been in the yield of channel bass, from 1,129,676 pounds, worth $51,212 in 1897, to 881,150 pounds, worth $38,808 in 1902. Other decreases were in sheepshead, from 464,024 pounds, worth $21,514, to 217,330 pounds, worth $9,739; croakers, from 134,700 pounds, worth $5,947, to 57,050 pounds, worth $2,368; mullet, from 39,250 pounds, worth $1,445, to 11,600 pounds, worth $276. On the other hand there was an increase in the seine catch of trout from 994,520 pounds in 1897, to 1,075,800 in 1902; drum, from 50,400 to 157,400 pounds; pike, from 22,730 to 57,300 pounds; and Spanish mackerel, from 40,710 pounds, worth $1,939 in 1897, to 55,330 pounds, worth $4,069 in 1902.

A small decrease occurred in the yield of oysters during the interval between the two years under comparison, but this was more than offset by an increase in the value. In 1897 the yield was 355,910 bushels, worth $94,663, whereas in 1902 it was 343,113 bushels, for which the fishermen received $100,359. The development of oyster culture in this state, which seemed so promising a few years ago, is receiving little attention at the present time.

The red-snapper fishery presents the most interesting feature in connection with the recent development in the fisheries of Texas. In 1890 the yield of this species was only 4,800 pounds, worth $240; in 1897 it was 464,791 pounds, worth $17,453, and in 1902 it was further increased to 2,067,987 pounds, worth $103,398. At the close of 1902 there were 15 vessels engaged in this fishery, with good prospect of a considerable extension. The greater number of the vessels are of the best type of schooner rig, measuring about 40 tons, and carrying a crew of 10 men each. The fishing grounds are located several hundred miles south of Galveston. In addition to the catch of red

snapper, these vessels caught 60,222 pounds of jew-fish and 40,169 pounds of groupers in the year covered by these returns.

An interesting attempt was made in 1902 to station these vessels on the fishing grounds and by means of a fast steamer carry supplies to them and transport the catch to market. The enterprise was not a success, however, due probably in a large measure to the fishermen's dislike to remaining away from port for a great length of time.

The yield of green turtle is rapidly decreasing on the Texas coast. In 1890 it amounted to 585,000 pounds, worth \$9,425; in 1897 it was 237,385 pounds, worth \$6,860, and in 1902 it was further reduced to 97,060 pounds, worth \$3,388. It will be observed that with the decrease in quantity there has been a corresponding increase in the value per pound. Relatively few turtle nets are now used, and the canning of turtle has been abandoned.

The quantity of fish taken by spears, cast nets, lines and dip nets, is insignificant and varies little from year to year. Indeed, these can scarcely be called professional fisheries, being prosecuted mainly at odd times and largely by boys. The total extent of these as well as of the fisheries mentioned above, is presented in the following series of tables, showing the number of persons engaged, the boats, apparatus, etc., employed, and the quantity and value of the products of the fisheries of Texas in 1902:

Table of persons employed in the fisheries of Texas in 1902.

How engaged.	No.
On vessels fishing	272
In shore or boat fisheries	783
On shore, in fish houses, etc	89
Total	1,144

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	62	\$107,655	Apparatus—shore fisheries—Con.		
Tonnage	939		Turtle nets	288	\$726
Outfit		25,286	Cast nets	115	357
Boats	561	58,964	Lines		110
Apparatus—vessel fisheries:			Dip nets	80	20
Seines	21	2,315	Spears	105	53
Lines		588	Tongs	225	1,266
Tongs	72	414	Shore and accessory property		79,050
Apparatus—shore fisheries:			Cash capital		82,500
Seines	145	14,420			
			Total		373,724

Table of products.

Species.	Lbs.	Value.	Species.	Lbs.	Value.
Blue-fish	16,350	$721	Red snapper	2,067,987	$103,398
Buffalo-fish	6,000	320	Sheepshead	217,330	9,739
Cat-fish	75,000	3,189	Spanish mackerel	63,830	4,621
Channel bass	898,450	39,525	Trout	1,119,300	49,577
Crevalle	6,680	192	Whiting	41,700	1,596
Croaker	58,050	2,408	Other fish	21,650	722
Drum	157,400	3,188	Shrimp	290,815	8,566
Flounders	240,900	11,093	Crab	a 42,800	2,022
Groupers	40,169	1,195	Turtle	97,060	3,388
Hog-fish	4,900	204	Terrapin	5,850	765
Jew-fish	65,722	2,137	Oyster	b 2,401,791	100,359
Mullet	16,800	412			
Pike	57,300	2,239	Total	8,044,404	353,814
Pompano	30,570	2,238			

a 128,400 in number. b 343,113 bushels.

STATISTICS BY COUNTIES.

There are ten counties in Texas having coast fisheries. Those in which the industry is of greatest importance being Aransas, Calhoun, Galveston, and Nueces. Statistics of the fisheries by counties are presented in the following tables:

Table showing, by counties, the number of persons employed in the fisheries of Texas in 1902.

Counties.	On vessels fishing.	Boat or shore fishermen.	Shoresmen.	Total.
Aransas	5	187	11	203
Brazoria		23		23
Calhoun	74	59	39	172
Cameron		26		26
Chambers		13		13
Galveston	162	262	13	437
Harris	3	28		31
Jefferson		23		23
Matagorda	13	16		29
Nueces	15	146	26	187
Total	272	783	89	1,144

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Texas in 1902.

Items.	Aransas.		Brazoria.		Calhoun.		Cameron.		Chambers.		Galveston.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	1	$700			23	$10,125					27	$90,880
Tonnage	9				139						708	
Outfit		395				6,178						15,746
Boats	113	13,660	28	$2,443	36	4,625	18	$860	15	$1,639	209	23,700
Apparatus—vessel fisheries:												
Seines	1	110			14	1,505					2	250
Lines												573
Tongs					34	196					21	125
Apparatus—shore fisheries:												
Seines	39	4,035	4	350	12	1,280	6	440	2	180	47	4,965
Turtle nets	240	480					20	36				
Cast nets	15	45			12	38	10	30			30	90
Lines		12		10		10		20				20
Dip nets											80	20
Spears	10	5			5	3					50	25
Tongs	28	140	15	80	10	50	4	20	7	42	112	672
Shore and accessory property		8,500		200		10,900		200		100		44,700
Cash capital		8,500				14,500						50,000
Total		36,582		3,083		49,410		1,606		1,961		231,766

Table showing, by counties, the vessels, boats, and apparatus employed in the fisheries of Texas in 1902—Continued.

Items.	Harris.		Jefferson.		Matagorda.		Nueces.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	1	$375			6	$2,900	4	$2,675	62	$107,655
Tonnage	5				48		30		939	
Outfit		215				1,162		1,590		25,286
Boats	22	2,140	26	$1,942	20	1,400	74	6,555	561	58,964
Apparatus—vessel fisheries:										
Seines	1	100					3	350	21	2,315
Lines		15								588
Tongs					13	73	4	20	72	414
Apparatus—shore fisheries:										
Seines	9	870	3	270	1	100	22	1,930	145	14,420
Turtle nets							28	210	288	726
Cast nets							48	154	115	357
Lines				36				2		110
Dip nets									80	20
Spears							40	20	105	53
Tongs	5	30	10	60	10	50	24	122	225	1,266
Shore and accessory property		200		400		100		13,750		79,050
Cash capital								9,500		82,500
Total		3,945		2,708		5,785		36,878		373,724

Table showing, by counties and species, the yield of the fisheries of Texas in 1902.

Species.	Aransas.		Brazoria.		Calhoun.		Cameron.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Blue-fish	10,000	$400	200	$8	600	$24	100	$4
Buffalo-fish					2,000	80		
Cat-fish	5,300	212	4,800	192	17,400	696	11,300	338
Channel bass	270,200	10,808	11,800	472	179,200	7,168	55,250	709
Crevalle	2,500	50					100	3
Croaker	9,500	190	500	20	4,100	161	2,000	25
Drum	152,000	3,040			600	24	100	2
Flounder	121,600	4,864	400	16	3,600	144	2,800	84
Hog-fish	2,600	104			300	12		
Mullet	7,600	164	600	24	500	20	2,600	50
Pike	36,200	1,448			4,200	168	6,500	174
Pompano	20,100	1,313	250	15	300	18		
Sheepshead	45,700	1,828	6,000	240	86,900	3,476	4,200	116
Spanish mackerel	46,450	3,017	300	18	550	33	500	28
Trout	266,400	10,656	17,000	680	133,700	5,348	64,200	1,129
Whiting	6,300	126						
Other fish	12,100	279	500	20	2,800	110	200	7
Shrimp	9,200	368			2,700	108	25,500	400
Crab							2,000	50
Turtle	51,760	1,924			3,500	128	9,900	198
Terrapin	1,430	186			1,240	173		
Oyster	230,860	8,476	92,820	3,315	552,370	20,910	35,700	1,260
Total	1,310,800	49,453	135,170	5,020	996,560	38,801	222,950	4,577

Table showing, by counties and species, the yield of the fisheries of Texas in 1902—Continued.

Species.	Chambers.		Galveston.		Harris.		Jefferson.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Blue-fish			3,050	$183				
Buffalo-fish							4,000	$240
Cat-fish			2,000	120	5,800	$320	17,500	875
Channel bass	12,000	$720	215,000	12,648	32,500	1,950	7,500	450
Crevalle			2,580	79				
Croaker	1,200	44	24,300	1,310	3,200	128	600	24
Drum			1,600	36			200	10
Flounder	400	24	50,800	3,432	3,850	231		
Grouper			40,169	1,195				
Hog-fish			400	24				
Jew-fish			65,722	2,137				
Mullet			3,200	96	1,000	30	100	4
Pike			1,000	60	700	35	300	18
Pompano			6,320	676				
Red snapper			2,067,987	103,398				
Sheepshead	2,400	144	34,800	2,088	15,280	875	3,500	210
Spanish mackerel	80	8	10,600	1,162	150	15	400	52
Trout	7,000	420	265,100	14,796	40,500	2,430	5,000	302
Whiting			35,400	1,470				
Other fish	200	12	2,800	164	600	30	250	12
Shrimp	2,000	80	127,600	5,054	2,400	96		
Crab			37,000	1,850				
Turtle			4,300	224				
Terrapin			2,460	320	120	26	600	60
Oyster	42,840	2,040	762,475	35,235	33,250	1,385	39,060	2,046
Total	68,120	3,492	3,766,663	187,757	139,350	7,551	79,010	4,303

Species.	Matagorda.		Nueces.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Blue-fish			2,400	$102	16,350	$721
Buffalo-fish					6,000	320
Cat-fish			10,900	436	75,000	3,189
Channel bass	5,200	$208	109,800	4,392	898,450	39,525
Crevalle			1,500	60	6,680	192
Croaker	800	32	11,850	474	58,050	2,408
Drum			2,900	76	157,400	3,188
Flounder	600	24	56,850	2,274	240,900	11,093
Grouper					40,169	1,195
Hog-fish			1,600	64	4,900	204
Jew-fish					65,722	2,137
Mullet			1,200	24	16,800	412
Pike			8,400	336	57,300	2,239
Pompano			3,600	216	30,570	2,238
Red snapper					2,067,987	103,398
Sheepshead	3,400	156	15,150	606	217,330	9,739
Spanish mackerel	200	12	4,600	276	63,830	4,621
Trout	6,500	260	313,900	13,556	1,119,300	49,577
Whiting					41,700	1,596
Other fish			2,200	88	21,650	722
Shrimp			121,415	2,460	290,815	8,566
Crab			3,800	122	42,800	2,022
Turtle			24,600	914	97,060	3,388
Terrapin					5,850	765
Oyster	271,530	9,570	340,886	16,122	2,401,791	100,359
Total	288,230	10,262	1,037,551	42,598	8,044,404	353,814

THE PRODUCTS BY APPARATUS.

The apparatus of capture employed in the coast fisheries of Texas in 1902 consisted of seines, turtle nets, cast nets, lines, dip nets, spears, oyster tongs, and rakes. In the vessel fisheries only seines, lines, and tongs were used, and the catch aggregated 3,457,883 pounds, valued at $159,839. The catch by boats in the shore fisheries was 4,586,521 pounds, valued at $193,975. The leading product in the vessel fisheries was the red snapper, while in the shore fisheries the yield of oysters was greater in both quantity and value than that of any other species.

In the following tables the vessel and shore fisheries are shown separately, and the products are given by each form of fishing apparatus:

Table showing, by counties, apparatus, and species, the yield of the vessel fisheries of Texas in 1902.

Apparatus and species.	Aransas.		Calhoun.		Galveston.		Harris.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Blue-fish	400	$16			50	$3		
Cat-fish	100	4	8,700	$348				
Channel bass or red-fish	9,200	368	115,200	4,608	18,900	1,134	4,000	$240
Crevalle					80	4		
Croaker	500	10	900	33	1,900	114		
Drum	7,000	140	600	24	100	6		
Flounder	3,600	144	200	8	700	42		
Mullet	400	8						
Pike	1,200	48	1,100	41				
Pompano	600	39			120	12		
Sheepshead	2,200	88	55,700	2,228	3,600	216	2,000	80
Spanish mackerel	1,200	78	150	9	300	34		
Trout	7,400	296	80,200	3,208	22,800	1,368	6,000	360
Whiting	300	6			200	10		
Other fish	600	19	500	20	100	6		
Shrimp	200	8	500	20	3,600	144		
Turtle	500	20	500	18	300	18		
Terrapin	30	6	240	48	60	20		
Total	35,430	1,298	264,490	10,616	52,810	3,131	12,000	680
Lines:								
Cat-fish							2,800	140
Grouper					40,169	1,195		
Jew-fish					60,222	1,807		
Red snapper					2,067,987	103,398		
Total					2,168,378	106,400	2,800	140
Tongs, etc.:								
Oyster			448,350	17,195	212,275	10,095		
Grand total	35,430	1,298	712,840	27,811	2,433,463	119,626	14,800	820

Apparatus and species.	Matagorda.		Nueces.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Blue-fish			600	$30	1,050	$49
Cat-fish			1,300	52	10,100	404
Channel bass or red-fish			16,900	676	164,200	7,026
Crevalle					80	4
Croaker			1,600	64	4,900	221
Drum			900	36	8,600	206
Flounder			1,800	72	6,300	266
Mullet					400	8
Pike			1,900	76	4,200	168
Pompano			1,000	60	1,720	111
Sheepshead			5,800	232	69,300	2,844
Spanish mackerel			1,600	96	3,250	217
Trout			43,400	1,736	159,800	6,968
Whiting					500	16
Other fish			600	24	1,800	69
Shrimp			3,200	96	7,500	268
Turtle			2,600	104	3,900	160
Terrapin					330	74
Total			83,200	3,354	447,930	19,079
Lines:						
Cat-fish					2,800	140
Grouper					40,169	1,195
Jew-fish					60,222	1,807
Red snapper					2,067,987	103,398
Total					2,171,178	106,540
Tongs, etc.:						
Oyster	141,750	$5,370	36,400	1,560	838,775	34,220
Grand total	141,750	5,370	119,600	4,914	3,457,883	159,839

Table showing by counties, apparatus, and species the yield of the shore fisheries of Texas, 1902.

Apparatus and species.	Aransas.		Brazoria.		Calhoun.		Cameron.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Blue-fish	9,600	$384	200	$8	600	$24	100	$4
Buffalo-fish					2,000	80		
Cat-fish	2,000	80	2,000	80	5,700	228	300	8
Channel bass	247,000	9,880	11,000	440	64,000	2,560	54,250	674
Crevalle	2,500	50					100	3
Croaker	9,000	180	500	20	2,200	88	2,000	25
Drum	145,000	2,900					100	2
Flounder	98,000	3,920	400	16	1,000	40	2,800	84
Hog-fish	2,600	104			300	12		
Mullet	6,000	120	600	24	500	20	600	10
Pike	35,000	1,400			3,100	124	6,500	174
Pompano	19,500	1,274	250	15	300	18		
Sheepshead	43,500	1,740	6,000	240	31,200	1,248	4,200	116
Spanish mackerel	36,750	2,387	300	18	400	24	500	28
Trout	221,000	8,840	16,000	640	52,000	2,080	62,800	1,073
Whiting	6,000	120						
Other fish	11,000	240	500	20	2,300	90	200	7
Shrimp	8,000	320			1,000	40	19,500	280
Turtle	3,000	110			3,000	110	1,600	44
Terrapin	1,400	180			1,000	125		
Total	906,850	34,229	37,750	1,521	170,600	6,911	155,550	2,532
Turtle nets:								
Turtle	51,260	1,794					8,300	154
Cast nets:								
Croaker					1,000	40		
Mullet	1,200	36					2,000	40
Trout	2,000	80			1,500	60	800	32
Other fish	500	20						
Shrimp	1,000	40			1,200	48	6,000	120
Total	4,700	176			3,700	148	8,800	192
Lines:								
Cat-fish	3,200	128	2,800	112	3,000	120	11,000	330
Channel bass	14,000	560	800	32			1,000	35
Spanish mackerel	8,500	552						
Trout	36,000	1,440	1,000	40			600	24
Crab							2,000	50
Total	61,700	2,680	4,600	184	3,000	120	14,600	439
Spears:								
Flounders	20,000	800			2,400	96		
Tongs and rakes:								
Oyster	230,860	8,476	92,820	3,315	104,020	3,715	35,700	1,260
Grand total	1,275,370	48,155	135,170	5,020	283,720	10,990	222,950	4,577

Apparatus and species.	Chambers.		Galveston.		Harris.		Jefferson.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Blue-fish			3,000	$180				
Buffalo-fish							4,000	$240
Cat-fish					3,000	$180	3,000	150
Channel bass	12,000	$720	195,600	11,484	28,500	1,710	6,500	390
Crevalle			2,500	75				
Croaker	1,200	44	22,400	1,196	3,200	128	600	24
Drum			1,500	30			200	10
Flounder	400	24	7,600	456	3,850	231		
Hog-fish			400	24				
Mullet			1,200	36	1,000	30	100	4
Pike			1,000	60	700	35	300	18
Pompano			6,200	664				
Sheepshead	2,400	144	31,200	1,872	13,280	795	3,500	210
Spanish mackerel	80	8	10,300	1,128	150	15	400	52
Trout	7,000	420	241,500	13,380	34,500	2,070	4,200	254
Whiting			35,200	1,460				
Other fish	200	12	2,500	150	600	30	250	12
Shrimp	2,900	80	118,000	4,490	2,400	96		
Turtle			3,400	170				
Terrapin			2,400	300	120	26	600	60
Total	25,280	1,452	685,900	37,155	91,300	5,346	23,650	1,424

Table showing by counties, apparatus, and species the yield of the shore fisheries of Texas, 1902—Continued.

Apparatus and species.	Chambers.		Galveston.		Harris.		Jefferson.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cast nets:								
Mullet			2,000	60				
Trout			800	48				
Other fish			200	8				
Shrimp			6,000	420				
Total			9,000	536				
Lines:								
Cat-fish			2,000	120			14,500	725
Channel bass			500	30			1,000	60
Jew-fish			5,500	330				
Trout			600	36			800	48
Total			8,600	516			16,300	833
Dip nets:								
Crab			37,000	1,850				
Spears:								
Flounders			42,500	2,934				
Tongs and rakes:								
Oyster	42,840	2,040	550,200	25,140	33,250	1,385	39,060	2,046
Grand total	68,120	3,492	1,333,200	68,131	124,550	6,731	79,010	4,303

Apparatus and species.	Matagorda.		Nueces.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Blue-fish			1,800	$72	15,300	$672
Buffalo-fish					6,000	320
Cat-fish			9,600	384	25,600	1,110
Channel bass	5,200	$208	92,900	3,716	716,950	31,782
Crevalle			1,500	60	6,600	188
Croaker	800	32	10,250	410	52,150	2,147
Drum			2,000	40	148,800	2,982
Flounder	600	24	7,650	306	122,300	5,101
Hog-fish			1,600	64	4,900	204
Mullet			1,200	24	11,200	268
Pike			6,500	260	53,100	2,071
Pompano			2,600	156	28,850	2,127
Sheepshead	3,400	156	9,350	374	148,030	6,895
Spanish mackerel	200	12	3,000	180	52,080	3,852
Trout	6,500	260	270,500	11,820	916,000	40,237
Whiting					41,200	1,580
Other fish			1,600	64	19,150	625
Shrimp			62,800	1,256	213,700	6,562
Turtle			3,500	140	14,500	574
Terrapin					5,520	691
Total	16,700	692	488,350	19,326	2,601,930	110,588
Turtle nets:						
Turtle			18,500	670	78,060	2,618
Cast nets:						
Croaker					1,000	40
Mullet					5,200	136
Trout					5,100	220
Other fish					700	28
Shrimp			55,415	1,108	69,615	1,736
Total			55,415	1,108	81,615	2,160
Lines:						
Cat-fish					36,500	1,535
Channel bass					17,300	717
Jew-fish					5,500	330
Spanish mackerel					8,500	552
Trout					39,000	1,588
Crab			3,800	122	5,800	172
Total			3,800	122	112,600	4,894
Dip nets:						
Crab					37,000	1,850
Spears:						
Flounder			47,400	1,896	112,300	5,726
Tongs and rakes:						
Oyster	129,780	4,200	304,486	14,562	1,563,016	66,139
Grand total	146,480	4,892	917,951	37,684	4,586,521	193,975

CONTRIBUTIONS TO THE BIOLOGY OF THE GREAT LAKES.

THE BIOLOGICAL RELATION OF AQUATIC PLANTS TO THE SUBSTRATUM.

BY

RAYMOND H. POND.

CONTENTS.

THE BIOLOGICAL RELATION OF AQUATIC PLANTS TO THE SUBSTRATUM.

By Raymond H. Pond.

INTRODUCTION.

This investigation was undertaken at the suggestion of Prof. Jacob Reighard, in charge of the biological survey of the Great Lakes under the auspices of the United States Fish Commission. It was carried on during three years, chiefly in the summer, partly at Put-in Bay, Ohio, and partly at Ann Arbor, Mich., under the direction of Prof. F. C. Newcombe, of the University of Michigan, to whom I am indebted for constant guidance. To Mr. A. J. Pieters, of the U. S. Department of Agriculture, I am indebted for the use of his very complete bibliography of aquatic plants. The discussion of the papers by Forel, Hoppe-Seyler, Seligo, and Stockmayer, constituting the introduction as well as the larger portion of the chapter on economic significance of results, is from the pen of Prof. Jacob Reighard.

One of the objects of the biological survey of the Great Lakes was to ascertain the factors which determine the quantity of food fish it is possible for these lakes to support. To this end it was necessary to study not only the fishes themselves, but all forms of animal and plant life in the lakes, for upon these, directly or indirectly, the fishes depend.

That the larger aquatic plants play an important part in the biology of fresh water has been long recognized, and at least two rôles have been assigned to them. The first of these is mechanical. Often the plants growing submerged are so abundant as to cover the bottom. Their fine rootlets give to the bottom soil greater coherence, while their stems and leaves protect it from the mechanical action of the waves. Such plants, moreover, form aquatic meadows in whose dense growth multitudes of small animals and young fish find shelter and concealment from pursuing enemies. Some fishes select these meadows as localities in which to lay their eggs, and the minute plant and animal

forms there present furnish a plenteous food supply for the young fish. Although the larger plants as such are, while living, little used as food by the aquatic animals, yet they greatly increase the surface available for the attachment of microscopic plant forms, which are eaten by the smaller animals, and the latter in their turn by the fishes. This relation of the larger plants to the food supply is, as Seligo (1890, pp. 46, 47) pointed out, chiefly mechanical and indirect.

The second rôle usually assigned to water plants is that of aeration, in which the plants by their carbon assimilation remove carbon dioxid from the water and give out oxygen in its place. Aquatic animals use the oxygen which is in solution in the water and give off carbon dioxid, which passes into the water, and which, if it should accumulate excessively, would become fatal to the animals. The water must, then, be constantly supplied with fresh oxygen and as constantly freed of the greater part of its carbon dioxid. In sunlight plants absorb carbon dioxid, and in using it for the manufacture of carbon compounds give off oxygen to the water in equal volume to the carbon dioxid absorbed, so that green plants during sunlight not only keep the proportion of carbon dioxid down, but actually become aerating agents by reason of their contributions of oxygen. Hence it has been the current belief that aquatic plants are necessary to furnish the oxygen needed by aquatic animals and to remove from the water the carbon dioxid injurious to the animals.

In 1890, however, Seligo indicated that the importance of the aeration rôle of aquatic plants has probably been exaggerated.

For, as is well known, plants need in their life processes not only the nourishing carbon dioxid, but like all other living things oxygen also, and while the excretion of oxygen takes place only in sufficient light, the absorption of oxygen goes on continuously. If then the oxygen content of water rich in plants must indeed be greater by day, so is it for the same reason much the less by night. At the same time equalization of gases must take place very rapidly in the comparatively shallow shore region of the lake basin, not only by access of the outer air, especially through wave motion, but also by diffusion within the water mass itself; and just as the assumption that forest air must be richer in oxygen than the air in the larger cities, for instance, has been shown by careful air analysis to be erroneous, so can the oxygen content of the shore water rich in plants be scarcely different from that which is free from plants. (Seligo, 1890, p. 47.)

Oxygenation of the superficial layers of water is accomplished by mechanical admixture of air through the action of waves, tributary streams, and rainfall, so that the upper 2 meters, over the entire surface of the lake, is practically saturated with the atmospheric gases. Oxygen thus absorbed from the air has been usually thought, as by Seligo, to diffuse with great rapidity into the deeper layers of the water, but Hoppe-Seyler (1896, p. 15) has measured the rate of diffusion of oxygen into motionless water from the atmospheric air and has found it extremely slow and wholly inadequate to account for the

relatively large volume of oxygen present in the deeper water of lakes (about 7.6 c. c., per liter of water). He thinks it probable that the migrations of animals from the superficial water toward the bottom and back again aid diffusion by mechanically mixing the water, thus maintaining the oxygen-content of its deeper layer. He has found that the percentage of oxygen at a depth of 245 meters in Lake Constance is 6.68 c. c. per liter and has shown by experiment (1896, p. 17) that a content of 3.3 c. c. per liter is, if continuously maintained, more than sufficient for the support of sensitive fishes, such as trout. To what extent this oxygen of the deeper layers of water owes its origin to plants of any sort is not known, but there is no reason to believe that any appreciable part of it is due to the larger rooted plants of the shore region. Hoppe-Seyler does not attempt to account for its presence. It is quite possible that the seasonal inversion in which the surface layer is carried to the bottom assists in maintaining the oxygen supply at very great depths. The carbon dioxid present in Lake Constance Hoppe-Seyler found to exist chiefly in the form of carbonates; but little of it (8.14 mg. per liter of water at 147 m. depth) exists free. From these results the conclusion may be drawn with entire definiteness that even at great depths in the lake and very near the bottom only little carbon dioxid is present uncombined, and therefore no hindrance to the respiration of the animals of the lake can occur from the carbon dioxid tension even at such depths.

The observations of Hoppe-Seyler, then, show that the upper layers of the water of the lake to a depth of 2 meters are practically saturated with oxygen, not only where larger aquatic plants are growing, but where there are no such plants. These plants can therefore have no practical effect in increasing the oxygen content of the superficial layer of water. Since his observations show further that in no part of the lake, even at great depths, and in other situations destitute of larger aquatic plants, is there more than a small quantity of uncombined carbon dioxid present, it is clear that the larger plants are not essential for the removal of this gas from the water. It is removed rather as a free gas, by the formation of carbonates. The statement, however, that the larger aquatic plants can not be regarded as essential for the furnishing of oxygen to the animals of a lake or for the removal of carbon dioxid injurious to those animals must be understood as applying only to lakes of considerable size—not to small ponds nor to standing aquaria.

Since the larger plants are scarcely used directly as food by fishes and are of no demonstrated aeration importance in lakes, it remains to determine whether they form one of the links in the chain of nutritive relations that stretches from the water and the soil to the higher fishes; whether, in other words, the plants have, in addition to their mechanical rôle, a nutritive rôle also. If we follow it backward from the fish,

the chain of nutritive relations leads us through the smaller animals chiefly to the microscopic plants, which depend for their food supply upon the carbon dioxid and various other substances in solution in the water. The presence of the other substances is due to various causes; they are brought by tributary streams and by the erosion of the shores; they are washed in from the air by rains, and they come from numerous accidental sources. In solution in the water they are the ultimate sources of food for fish; yet neither fish nor the animals upon which fish feed can secure nourishment from these sources directly. Plants must intervene to organize the mineral salts and carbon dioxid of the water into food.

The aquatic plants may be considered in two groups, one including those which are attached to the soil by roots and the other comprising those which float free or are without organs of attachment. The latter are mostly microscopic, and taken together are designated as the vegetable plankton or phyto-plankton in distinction from the minute free-swimming animals, which as a whole are spoken of as animal plankton or zoö-plankton. In the case of the free plants, food must be obtained from the water which surrounds them, and a deficiency of any one of the substances now known to be essential for plant growth means a reduced quantity of vegetable plankton, and consequently a limited food supply for the fish. The forms of the phyto-plankton require nitrogen, potash, and phosphoric acid just as other plants do, and Brandt (1899) has based upon the work of Apstein the statement that the amount of plankton varies directly with the proportion of nitrates dissolved in the water. The view hitherto usually held has been that the rooted aquatic plants also take their nourishment directly from the water and not at all from the soil; that their roots consequently are organs of attachment only, not organs for drawing nutrition from the soil. If this be true the larger aquatics must, during the growing season, withdraw from the water large quantities of nutritive substances which would otherwise be available for the phyto-plankton, thus lessening the amount of phyto-plankton that the water is capable of producing during this period, and consequently lessening the supply of fish-food dependent on this phyto-plankton. By the subsequent decay of these larger aquatics the food materials withdrawn by them from the water would be returned to it and made available for the phyto-plankton; but while they would thus on the average not lessen, they would, on the other hand, not increase the supply of food for the phyto-plankton.

If, however, the view just expressed be incorrect, and if the larger aquatics draw their supply of mineral food not from the water but from the soil, they draw upon a source which is not available for the phyto-plankton. Their growth, then, does not at any time lessen the supply of phyto-plankton; on the contrary when the larger aquatics

decay, the substances that they have drawn from the soil come into solution in the water and there add to the supply of food available for the phyto-plankton. In thus transferring food materials from the soil to the water these plants would serve a most important function, analogous to the fertilization of land.

According to the usual view, the larger aquatics in their aeration and mechanical rôles tend to increase the supply of fish, while in their nutritive rôle they tend during the growing season to diminish it, though on the average not affecting it. From the alternative view, they tend in all rôles to increase the supply of fish. It thus becomes important to determine the source of nutrition of the larger attached aquatic plants.

HISTORICAL REVIEW.

Unger (1861) was probably the first to suggest the absorption and excretion of water in submerged aquatics. The existence of amphibious species and those subject to sudden inundation did not escape his notice. It seemed unreasonable to him to suppose that the leaves of amphibious plants, when exposed, should act as organs of transpiration, and, when suddenly submerged, as organs of absorption. He preferred to think that there is an upward current in water plants as well as in land plants, and he endeavored to show that there is a measurable excretion of water by the leaves. He experimented as follows: Two jars filled with water were placed side by side and a U-tube hung on the adjacent edges, so that one shank of the tube descended into each jar. Plants of *Potamogeton crispus* were so arranged that their roots were in one jar, while the stems, passing through the U-tube, were in the other jar. The total leaf surface of the plants was 126 quadricentimeters and they bore 7 adventitious roots several inches long. A preparation similar to the preceding, except that the roots were removed, served for a control. At the end of a week the volume of water in the jars containing the stem portions had in the first-mentioned case increased 1.6 grams, and in the control none whatever. Unger obtained a similar result with *Ranunculus fluitans*.

These experiments were not accepted by Strasburger (1891) and Hochreutiner (1896), although neither of these men makes specific objection. The best reason for not accepting Unger's results is that he fails to show that his method of measurement was sufficiently accurate. An increase of 1.6 grams is a rather small amount, and unless we know that the experimental error must have been less than this the result is to be questioned.

Schenck (1886) states that the roots are primarily organs of attachment, arguing that this must be true since the necessary amount of mineral salts is absorbed directly through the epidermis. This is purely an assumption on the part of Schenck, as there is no experimental evidence to support the view.

Sachs (1887) says: "In algæ, and even in some aquatic phanerogams, the roots are chiefly, or it may be exclusively, organs of attachment."

Frank (1890) observes that while some aquatics swim freely, there are still those whose roots penetrate the substratum and function as do the roots of land plants.

Sauvageau (1891) argues, on page 281, that if one of the uses of the circulation of water in the plant is to supply nutritive substances, this ought to be relatively important in the case of submerged plants, because the water in which they live is oftentimes less rich in dissolved salts than that which circulates in the soil (no authority cited). Continuing, he notes that the roots of certain aquatic plants are well developed. Species of *Potamogeton*, *Naias*, and *Zostera* have well-developed roots, and the root hairs persist longer than the other cells of the piliferous layer. Species of *Potamogeton* have leaves of two sorts—namely, submerged, without stomata, and exposed, with stomata. On page 282 Sauvageau states that the total surface of the floating leaves is always less than that of the submerged. His hypothesis is that the processes of absorption, conduction, and giving off of water necessitated by the floating leaves are not suddenly initiated at the moment the floating leaves reach the surface, but must have been in operation during the period when the floating leaves were still undeveloped, and likewise in those plants wholly submerged, since their roots serve not only mechanically for attachment, but also for absorption. On page 285 he claims to have demonstrated, by direct measurement of the water passing through the stem of immersed cuttings, that aquatic plants absorb and give off water by a process comparable to that of land plants. It must be noted, however, that in his experiments only fragments of plants were used. In no case did he employ an entire plant with roots. He says that if the plants used had been provided with roots the absorption would have been greater. A careful review of his paper reveals the fact that his conclusion is not warranted. Minden (1899) makes the same objection to Sauvageau's conclusion.

Strasburger (1891) observes that in submerged plants the function of the tracheæ is much diminished; that the salts in the surrounding water may be absorbed by the entire surface of the plant; and that, since there is no transpiration, there is no ascending current. He repeated Unger's experiment, previously described, but failed to get positive results. Instead of using the same plants that Unger used, however, he tried *Ceratophyllum demersum*, and as this plant does not develop roots, his negative result has no significance with regard to Unger's experiment. Moreover, the value of his experiment is doubtful because he speaks of allowing his *Ceratophyllum* plants to take root in flowerpots before beginning the test—an impossible thing, since the plant does not have roots, a fact which he mentions on the preceding page.

Ludwig (1891) gives expression to the current opinion that the roots of aquatic plants serve only for attachment and are without root hairs, and refers to Schenck.

Wieler (1893) states that *Elodea* and *Ceratophyllum* bleed, and since the vascular system of these plants is very rudimentary the movement of water must occur in the intercellular spaces, into which water is forced by adjacent cells, perhaps as in land plants. In consideration of this opinion it is only necessary to note that mere bleeding does not necessarily signify an ascending current, similar to that of land plants.

In the Bonn text-book (Noll, 1902) is the assertion that in general it is true of all submerged aquatics, even phanerogams, that they are able to absorb nutritive solutions through the surface of the whole body, and plants obtaining their food in this way either have no roots or the roots serve merely as mechanical holdfasts.

Hochreutiner (1896) was the last to investigate the transport of water in submerged plants. His experiment No. 1, with *Ranunculus aquatilis*, illustrates the method employed by him. Two vessels standing adjacent were used, one containing aqueous eosin solution and the other "pure" water. One cutting had its base immersed in the eosin to a depth of 1.5 cm. and its upper portion immersed in "pure" water. A second cutting had 9 cm. of its upper part in eosin and its base in "pure" water. The exposed parts were greased to prevent capillarity and the preparation was kept in a saturated atmosphere. After a day and a half it was found that the eosin could be detected in the main stem of the first plant 9.5 cm. from its base; in a lateral branch 6 cm.; in a leaf 8 cm. The second plant, having 9 cm. of its upper stem in the eosin, showed a coloration in the vascular system through only the apical 3 cm. of the stem. Hochreutiner concludes that in these plants there is an upward current; and although there may be some absorption by the leaves, it is slight compared with that of the roots, these aquatics obtaining their nourishment in the same way that land plants do. He further argues that since there is an upward current there must be also excretion of water by the leaves; and he seems to consider transpiration, or better, exudation, possible in these cases. He endeavored to measure the exudation, but was unable to overcome the practical difficulties. The one objection to Hochreutiner's experiments is that his plants did not have roots[a], and that the eosin entered the exposed vascular system. Although he showed that capillarity would not account for the rate of current, it still remains that conclusions as to the behavior of plants with roots can not be drawn from the behavior of plants without roots.

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[a] Hochreutiner (1896). In a review of this article, in Botanisches Centralblatt, 1898, vol. 68, p. 366, it is stated that the eosin was offered to the roots, but reference to the original shows this is plainly an error. Thus it is probable that A. J. Pieters, Plants of Western Lake Erie (Bulletin U. S. Fish Commission, 1901, p. 73), had access only to the abstract mentioned.

In Vines's Text-book (1896) is the statement that "submerged aquatic plants absorb their food entirely or mainly from the water in which they live." Coulter (1900) agrees with the opinions of Schenck and Strasburger.

The literature thus far reviewed permits one to consider these writers in two groups, one including those whose opinions are derived a priori, assuming that the plants are surrounded by a nutritive solution and that absorption can take place through the epidermis; the other including those who have investigated and who feel warranted in concluding that these aquatics obtain their nourishment by a process comparable to that of terrestrial plants.

Pfeffer (1897) expresses the opinion that a circulation of water in aquatic plants is possible, and he reviews the literature briefly, stating that the experiments of Unger, Wieler, and Hochreutiner are not conclusive, and that the opinions of Strasburger and Sauvageau are not supported by experimental evidence. Also, on page 297, Pfeffer says that no decisive experiments concerning excretion of water in submerged or amphibious plants have yet been made.

The preceding review of literature deals more particularly with the work and opinions of botanists and shows that they are by no means in agreement. On the other hand, however, those who have dealt with the subject from a more general botanical or biological standpoint have given reason for belief that rooted aquatic plants derive nourishment from the soil. Seligo (1890, p. 48) expresses the opinion that the fertility of the bottom should have an effect on the development of shore plants, and points out that in regions where the soil of the adjacent land is fertile the shore region of the lakes is almost everywhere better covered with vegetation than in sterile regions. He then says: "Yet this influence is not so decisive as it appears to be, for a great part of the shore vegetation (algæ) takes its nourishment, not from the bottom, but from the water." Seligo thus, by implication, expresses his belief that larger aquatics draw their nourishment from the soil.

Stockmayer (1894, p. 136) cites a case in which an alga (*Desmonema wrangelii*) appears to depend on a substratum of gneiss.

Pieters (1901, p. 75), in his work on the plants of Lake Erie, showed that there is a probable relation between the abundance of aquatic vegetation and the character of the bottom soil as revealed by mechanical analysis. "As a rule, the soils on which the plants occurred in abundance were composed largely of sand and very fine sand, and contained relatively little silt, fine silt, and clay, while the soils on which few or no plants occurred, although the depth of the water and other physical conditions were favorable, were composed largely of silt, fine silt, and clay, and were poor in fine sand and very fine sand."

Forel (1902, p. 183) says: "In fact, it is classical in botany that aquatic plants are not nourished through their roots, which serve only as organs of attachment; they have no need of humus. Now, however unstable the sand may be, it seems that roots sufficiently deep—nearly all our lacustrine plants have roots—should be able to obtain a sufficient insertion in it. This fact, added to the well-known case of *Elodea canadensis*, which, after having had an abundant vegetation during the first period of its invasion of a new territory, becomes reduced to relatively modest proportions at the end of some years—it seems that it has exhausted the soil—ought not these facts to engage physiological botanists anew in a study of the dogma that the roots of aquatic plants serve only as organs of attachment? It may be possible, however, that they have a certain nutritive function for the plant."

COMPARATIVE STUDY OF GROWTH UNDER VARYING CONDITIONS OF NUTRITION.

In planning the experiments for this part of the work it was assumed that, other conditions being equal, the one of nutrition determines the volume of vegetation produced. The first endeavor was to determine whether the soil is necessary for optimum growth. For this purpose conditions most nearly approaching the natural ones are desirable, and these are easily obtained in summer by means of floating aquaria, which are described in detail in the succeeding pages.

If the soil is necessary for optimum growth, it may be so chiefly for two reasons, one of these being that it furnishes nourishment, the other that it serves merely as a substratum in which plants may be anchored. In the former case the roots would function as do those of land plants, and in the latter merely as mechanical holdfasts.

If the soil serves merely as a substratum, it would seem that clean washed sand ought to do equally well. For the investigation of this phase of the problem glass aquaria were used, and in these the effects of sand and soil substrata on growth were compared. Further, if the supernatant water tends to extract nutritive salts from the soil, the water above humus soil ought to support a better growth of plants anchored in it than water above clean washed sand. This subject has also received attention, and the methods employed will be described later.

Again, if aquatics do absorb salts through the epidermis, they ought to make an optimum growth in suitable nutritive solutions. The behavior of these plants in culture solutions will also be considered.

INFLUENCE OF SUBSTRATUM.

VALLISNERIA SPIRALIS.

This plant occurs usually in water from 15 cm. to 3.5 m. in depth, though Evermann (1902) noted it growing at a depth of 22 feet. It thrives also in shallow running water where a soil substratum is covered by a shallow stratum of gravel and the water remains clear. It prefers a firm soil substratum and never occurs in pure gravel or sand, but its roots will penetrate a thin stratum of sand or gravel to soil beneath, and it may be found rooted in the soil deposits between coarse and loosely lying stones. The roots occur as tufts at the nodes of the creeping rootstock, are fibrous, unbranched, and clothed with root hairs, which are certainly more abundant than is suggested in any literature that has come to my notice. Schwarz (1881–1885) states that one may examine four of five roots of *Vallisneria* before finding root hairs. My observation compels me to differ and to state that this would be exceptional if the plants examined were carefully removed from the soil. On detached and floating specimens exposed to intense light the root hairs soon disappear by death and decay. Schenck (1886a) states that *Vallisneria* and *Elodea* do not develop root hairs, but he is certainly mistaken.

In removing specimens from the soil it is common to find shells pierced by the roots or to find fragments of limestone adhering to them, so it is quite probable that the roots have a corrosive effect upon these insoluble fragments of rock.

The leaves arise from the creeping rootstock, and the older ones have an apical opening similar to that described by Sauvageau (1891) for some other aquatic species. The opening is formed by disintegration of the apical tissue, and results in exposing the vascular system directly to the surrounding medium. In very young leaves this opening could not be found, but it was usually present in leaves 25 cm. or more in length. As a rule, the length of the leaves exceeds the depth of water in which they occur, the upper portion floating horizontally near the surface. This is especially true when the plants are crowded in slowly running water. In the latter case it often happens that the leaves exposed to the intense light turn brown and decay.

Experiment No. 1.—This experiment was conducted at the laboratory of the U. S. Fish Commission at Put-in Bay, Ohio, during the period of four weeks from July 18 to August 18. Floating aquaria were constructed as follows: Around the top of two wooden boxes was built a raft large enough to float the boxes, the latter being about 1 m. wide, 1.5 m. long, and 75 cm. deep. In one box was placed a substratum of soil selected from a locality in which *Vallisneria* was abundant. The aquaria were then anchored in the lake and weighted so that they floated, submerged a few centimeters below water surface.

This arrangement furnished the closest approximation to natural conditions. Wooden bars 15 mm. square in cross section and a little less than 1 m. in length

were notched at convenient intervals and upon these the plants were mounted in the following manner: One face of the wooden bar was covered with a ribbon of cheese cloth, fastened with bits of cotton twine which encircled the bar at the notches. A second ribbon of cheese cloth was fastened over the first at one end of the bar. As the plants were placed in the intervals between the notches the outer ribbon of cheese cloth was passed over them and tied to the bar so as to hold them securely. Fifty plants were mounted in this manner, all manipulation being performed under water. Of these 50 individuals 25 were planted in the box containing soil, so that the roots were buried in the mud, the bars being weighted at each end. The remaining 25 plants were placed in the box not containing a substratum. The bars on which the plants were mounted were set horizontally 15 cm. above the bottom of the box.

The plants were taken from the lake by means of a long-handled shovel, with which a portion of soil containing several plants could be raised. By carefully washing away the mud, specimens could be secured without injury to the roots. Young plants of uniform size were selected.

At the end of four weeks in the aquaria the plants were gathered, carefully washed, and air-dried. The total weight of suspended plants was 15 grams and of those

FIG. 1.—*Vallisneria spiralis* after 7 weeks growth rooted in lake soil. Plants in figures 1 and 2 originally the same size.

rooted in soil 20 grams, a difference of $33\frac{1}{3}$ per cent of the former. The plants rooted in soil looked as strong and healthy as those in the lake, and several new individuals had arisen from the rhizomes. The anchored plants did not look so well; only a few new individuals had appeared, and these were stunted in growth. The original plants had grown very little.

Experiment No. 2.—This experiment also was conducted at Put-in Bay, Ohio, during the period of seven weeks from July 18 to September 5. It will be noticed that in the preceding experiment, the roots of the suspended plants were exposed to the light prevailing at the depth of 60 cm. That this condition was not a disturbing factor may be inferred from the following experiment:

Two rectangular glass aquaria, each with a capacity of approximately 50 liters, were located on the lake shore. One contained a layer of lake soil 5 cm. deep, the other carefully washed fine gravel from the lake. The same number of plants, uniform in size, was planted in each. The water in the aquaria was siphoned off daily and fresh water from the lake supplied.

At the end of seven weeks a very marked difference could be noticed in the amount of growth of the two sets of plants. Those in gravel were short, bleached, and almost dead. No new shoots had arisen from the rhizomes. The plants in soil were in excellent condition, of good size and color, and 9 new shoots had arisen from the rhizomes. (Compare figures 1 and 2.) It is evident that in both of these experiments the difference in the amount of growth must be attributed to the difference in the environment of the roots.

RANUNCULUS AQUATILIS TRICHOPHYLLUS.

This species lives wholly submerged in shallow, slowly flowing water. The leaves are finely dissected and incapable of supporting themselves when the plant is taken from the water. The stem branches freely, any branch being able to continue the growth of the plant if the main stem be removed. Roots may arise at any exposed node except, perhaps, the terminal one. If a fragment, a few internodes in length, be detached and left floating roots will arise at the

FIG. 2.—*Vallisneria spiralis* after 7 weeks growth rooted in gravel. Plants in figures 1 and 2 originally the same size.

nodes in from six to ten days. These roots grow directly downward, and shortly after entering the soil contract, at least the stem fragment is drawn toward the soil. While the roots are elongating toward the substratum the stem does not elongate, but it quickly resumes growth in length after the roots have entered the soil. More roots then arise from higher nodes, and as those enter the soil the plant is drawn farther down until it is firmly anchored. The roots do not branch before reaching the soil, but do so very shortly after the substratum is penetrated. Numerous lateral roots arise and are formed in succession as the main root advances. A plant with such a root and young lateral roots was carefully removed from the soil and left floating. Neither the main root nor its branches continued to grow, but new roots arose from the upper nodes which again anchored the plant.

The roots are well supplied with hairs; those arising from floating fragments are often almost entirely covered. In one instance a root was found to be clothed with hairs for a distance of 45 cm., which was practically its whole length. The roots are strongly geotropic, and always regain the vertical position if displaced from it.

In each of the following experiments two rectangular glass aquaria of about 50 liters capacity were used. One of these contained a substratum of suitable soil from the bed of a stream and the other contained thoroughly cleaned sand. Considerable pains were taken to remove all the soil particles from the sand, which was accomplished by first washing it as clean as possible, then allowing it to soak for several hours and again washing it, this process being continued until the sand was entirely clean.

A certain number of cuttings from the stock aquaria were planted in the substratum in one end of each aquarium, and in the other end a like number of cuttings were anchored in the supernatant water. To keep these suspended cuttings wholly submerged and in vertical position a small piece of glass tubing was attached by a short cord to the basal node of the cutting. Crystallizing dishes received the roots that developed from the suspended cuttings and prevented their contact with the substratum. By means of a siphon the water in each aquarium was removed on an average of about once a week, fresh water being allowed to enter from the tap above the aquarium as the stale water siphoned out. In this way a complete renewal of water was effected without injury or disturbance to the plants.

Experiment No. 3.—In this instance the aquaria were located in the greenhouse at Ann Arbor. The temperature varied from 16° to 22° C., and many of the days were cloudy. The duration of the test was from January 2 to March 5, a period of about sixty days. Terminal portions of plants from the stock aquarium were selected, and 10 such cuttings of uniform length and quality, having neither branches nor roots, were placed in each of the four conditions previously mentioned. After a period of sixty-one days positive differences in the growth of the four groups could be observed.

Growth measurements of Ranunculus aquatilis trichophyllus at the end of sixty-one days. Original length of each cutting, 15 cm.

Condition and specimen number.	Number of internodes on main stem.	Length of main stem.	Number of lateral branches.	Length of lateral branches.	Total length of stem and branches.
		Cm.		*Cm.*	*Cm.*
1. Rooted in soil:					
1	12	68	5	69	137
2	12	50	8	39	89
3	12	53	4	42	95
4	13	75	6	53	128
5	13	48	7	84	132
6	13	60	3	14	74
7	12	62	5	36	98
8	11	45	0	0	45
9	8	40	3	31	71
10	6	35	3	20	55
Total	112	536	44	388	924
2. Rooted in sand:					
1	13	40	0		
2	16	60	0		
3	14	70	0		
4	13	50	0		
5	14	68	0		
6	12	50	0		
7	14	55	0		
8	12	55	0		
9	14	64	0		
10	14	55	0		
Total	136	567	0		
3. Anchored over soil:					
1	12	42	0		
2	12	31	0		
3	11	32	0		
4	11	31	0		
5	10	26	0		
6	9	28	0		
7	10	28	0		
8	11	35	0		
9	11	30	0		
10	11	30	0		
Total	108	313	0		
4. Anchored over sand:					
1	11	40	0		
2	12	42	0		
3	10	27	0		
4	11	40	0		
5	6	22	0		
6	7	22	0		
7	10	22	0		
8	14	36	0		
9	15	60	0		
10	8	26	0		
Total	104	337	0		

The roots of anchored plants were exposed to light, and this fact must be remembered when comparing these plants with those whose roots entered the substratum. If, however, the roots are only for attachment, then exposure to light should not be a disturbing factor in the amount of growth of the rest of the plant.

Referring to the above tables, the most notable feature is that only one of the cuttings rooted in soil failed to develop lateral branches, while not a single plant of the other three groups developed a lateral branch. Although the total growth of the plants rooted in sand slightly exceeds that of the main stem of those rooted in soil, the large number of lateral branches developed by the latter increases their total

growth to a length greatly in excess of the former. The two groups of anchored plants are practically equal in all respects, and it would seem that the water over sand furnishes as much nourishment as that over soil. The plants rooted in sand grew better than those anchored, but not nearly so well as those rooted in soil. Lateral roots develop abundantly in the sand, and thus those plants had a much more extensive root system.

The following percentages, calculated from the tables, afford a convenient summary of measurements for comparison. An allowance of 10 per cent should be made for individual variation unaccounted for.

Comparing with respect to total length:

Plants rooted in soil exceed plants rooted in sand 62.96 per cent of the latter.
Plants rooted in soil exceed plants anchored over soil 195.20 per cent of the latter.
Plants rooted in soil exceed plants anchored over sand 174.18 per cent of the latter.
Plants rooted in sand exceed plants anchored over soil 81.15 per cent of the latter.
Plants rooted in sand exceed plants anchored over sand 68.25 per cent of the latter.
Plants anchored over sand exceed plants anchored over soil 7.66 per cent of the latter.

POTAMOGETON PERFOLIATUS.

This plant grows wholly submerged at a depth varying from a few centimeters to a meter. It is most abundant in protected coves, and is always found attached to a substratum containing some soil. Loamy soil seems to be its first choice, but a fair growth is often attained on a clayey or sandy bottom. The plants growing in very shallow water seldom fruit, while those in the deeper water usually do. Vegetative propagation by creeping root-stocks is conspicuous. The leaves are thin, broad, with clasping base, and ribbed. The plants appear early in the season and the root-stocks probably remain alive through the winter. The growing root-stocks will turn green if left exposed long enough, and are sensitive to either light or gravitation or to both. If a cutting of the erect stem be suspended, roots do not arise from the nodes of the cutting, but instead rhizomes are formed, and from the nodes of the rhizomes new roots arise. The roots occur as fibrous tufts at the nodes of the creeping root-stock and are unbranched. Root hairs are common, but not so abundant as in *Elodea* or *Ranunculus*.

Experiment No. 4.—The location and conditions remain as in the preceding experiment, the duration being from June 6 to July 25. In this case the aquaria stood outdoors instead of in the greenhouse, and to secure a cool substratum and to prevent the water from becoming too warm they were sunk 10 cm. into the earth. It was also found necessary to protect the plants from intense light, and this was done by shading the south side of the aquaria with felt paper, in such manner that the plants in each received practically the same amount of light. Water connections were made with a hydrant, so that fresh water could be supplied, and the stale water was siphoned out weekly.

Cuttings of terminal portions 15 cm. in length were taken from young and fresh river plants, and 10 were placed in each of the four conditions used in the preceding experiment. These cuttings were without roots or rhizomes, and, in distinction from the new growth arising from them during the experiment, are designated "original cuttings."

Growth measurements of Potamogeton perfoliatus at the end of seven weeks. Original length of each cutting, 15 cm.

Condition and specimen number.	Length original cutting.	Number of nodes on original cutting.	Number of rhizomes.	Total length of rhizomes.	Number of nodes on rhizomes.	Number of secondary shoots.	Total length secondary shoots.	Number of nodes on secondary shoots.
1. Rooted in soil:	*Cm.*			*Cm.*			*Cm.*	
1	20	18	2	70	15	7	170	119
2	18	17	2	62	12	9	172	128
3	18	18	1	60	13	8	147	126
4	16	20	1	54	14	8	222	154
5	17	18	1	84	17	9	165	126
6	16	13	1	70	15	7	208	150
7	17	17	2	116	26	12	304	251
8	18	19	2	132	25	15	379	261
9	18	18	1	211	45	21	510	363
10	16	17	2	190	42	20	487	339
Total	174	175	15	1,049	224	116	2,764	2,017
2. Rooted in sand:								
1	17	19	3	35	10	7	31	45
2	[a] 28	12	2	46	14	8	22	35
3	16	20	3	38	9	9	40	52
4	16	19	2	22	6	6	30	45
5	15	19	2	40	13	9	30	39
6	17	18	3	22	5	5	30	27
7	15	20	2	40	13	9	45	50
8	18	20	3	39	13	6	43	55
9	16	20	3	24	13	6	28	39
10	16	18	2	26	12	5	26	38
Total	174	185	25	332	108	70	325	425
3. Anchored over soil:								
1	16	19	2	43	19	7	16	26
2	17	17	1	30	11	4	8	13
3	16	19	2	55	20	8	19	32
4	17	19	2	50	20	9	14	22
5	[a] 28	13	2	33	11	6	12	24
6	15	16	3	48	22	7	9	23
7	17	20	2	50	18	9	15	30
8	17	20	2	50	19	10	20	31
9	15	13	3	30	14	6	12	18
10	15	15	2	41	17	9	11	19
Total	173	171	21	430	171	75	136	238
4. Anchored over sand:								
1	15	20	4	44	20	12	25	31
2	18	20	3	78	29	16	36	60
3	16	16	2	50	17	10	16	36
4	16	22	3	70	21	9	23	53
5	16	16	3	50	20	9	17	45
6	18	20	2	56	19	10	27	56
7	16	14	2	50	18	7	15	36
8	16	19	3	51	25	10	22	48
9	18	20	3	81	29	12	34	62
10	16	20	3	63	20	10	26	39
Total	165	187	28	593	221	105	241	466

[a] Fruited.

Summary of results in four conditions.

Items.	Rooted in soil.	Rooted in sand.	Anchored over soil.	Anchored over sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*
Average length of rhizome	69.93	13.28	20.5	21.2
Average length of rhizome-internode	4.7	3.07	2.45	2.7
Average length of secondary shoots	23.82	4.64	1.8	2.3
Average length of internode of secondary shoots	1 3	.77	.57	.5

From these tables it will be noted:

1. The original cuttings in each of the four conditions practically ceased to grow in length early in the experiment, adding on the average less than 3 cm. to the original 15 cm.

2. The new growth consisted of rhizomes and secondary shoots arising from them.

3. The plants rooted in soil produced on the average fewer rhizomes than those in any of the other three conditions.

4. The average length of the rhizomes arising from the plants rooted in soil greatly exceeded that of the rhizomes arising from the plants in each of the other three conditions.

5. The average length of the secondary shoots from the plants rooted in soil greatly exceeded that of the secondary shoots from the plants in the other three conditions.

6. The plants anchored over sand averaged about equally in all respects with those anchored over soil.

7. The plants rooted in sand exceeded in all respects, except the length of rhizome, the two groups of anchored plants.

In this species the habit of the plant persists whether the cuttings be in sand, in soil, or anchored, and the differences arising from the differences of environment are quantitative rather than qualitative. All of the plants produced rhizomes and secondary shoots. In *Ranunculus aquatilis trichophyllus*, however, it will be remembered that the natural habit of the plant persisted only in the individuals rooted in soil, lateral branches failing to develop in the other groups.

MYRIOPHYLLUM SPICATUM.

Quiet water 1 to 2 meters deep and a good loamy soil are the favorite habitat of this species. Isolated specimens occur in shallow water and sandy soil where they have been washed as drifting fragments, but the plants do not establish themselves under such conditions. Long branching roots are developed, but root hairs have never been found. Roots may arise at almost any node, and numerous stem branches arise to give the plant a bushy form. The leaves are finely dissected, the stem strong and flexible, so that the plant seems adapted to rougher water than that in which it usually occurs. I have never found it occupying any considerable area or so abundant as to suggest the exclusion of other species by it. As roots develop abundantly, but do not have root hairs, it was considered desirable to determine whether or not the plant is dependent upon its attachment to the soil for optimum growth.

Experiment No. 5.—The location and conditions remain as in experiments 3 and 4. The duration in this case is one month, from July 10 to August 10. Terminal cuttings 15 cm. in length and without roots were selected from thrifty river plants.

On August 10 the general appearance of the plants was as follows: The two groups of anchored plants were about alike in all respects and had numerous roots arising from

the 5 or 6 lowest nodes. These roots had no branches. The plants rooted in sand had numerous roots which were longer than those of the anchored plants, profusely branched and white. The plants rooted in soil were about equal to those rooted in sand in root development, but the roots were of a dark purple color, which is common, though not universal, in wild specimens. None of the roots arose from nodes above earthy substratum. The internodes in all cases were of about equal length. The only difference seemed to be merely that there was more growth in the plants rooted in soil.

Growth measurements of Myriophyllum spicatum at the end of 31 days. Original length of each cutting, 15 cm.

Specimen number.	Rooted in soil.	Rooted in sand.	Anchored over soil.	Anchored over sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*
1	55	38	38	55
2	79	41	31	47
3	84	38	35	38
4	44	57	36	45
5	54	59	36	66
6	50	60	46	42
7	75	35	28	20
8	77	39	39	33
9	84	35	27	22
10	76	61	34	30
Total	678	463	350	398

The measurements in the accompanying tables show:

(1) A positive difference in favor of plants rooted in soil.

(2) The two groups of anchored plants are practically alike.

(3) The plants rooted in sand exceed those anchored, but do not approach in growth those rooted in soil.

ELODEA CANADENSIS.

Either still or running water is suitable for *Elodea.* It grows attached to the substratum by adventitious roots arising at the nodes. I have never found lateral branches on the roots, although I have made several attempts to do so. The plant thrives in shallow or deep water and seems to be adapted to light of varying intensity. When growing in water a meter or two in depth the internodes are noticeably longer, the stem thicker and less branched. Roots arise quickly from the nodes of a drifting fragment. At Put-in Bay a large thrifty plant was found afloat, which bore a single root 90 cm. in length. *Elodea* likes a good loamy soil. It does occur in clay, and may frequently be noticed growing clustered in what appears to be a sand substratum, but I have always found some humus soil present in such cases.

Experiment No. 6.—The location and conditions are continued here as in preceding experiments, the duration being one month, July 10 to August 10. Terminal cuttings 10 cm. long were selected from fresh river specimens. These cuttings were alike in all respects, and were without roots or branches.

On August 10 little difference, if any, could be noticed in the plants rooted in sand, anchored over soil or anchored over sand. The diameter of the stem and the

length of internode were about the same for all, and all of the plants were of fairly good green color. Those rooted in soil were, in comparison, of a more delicate green and in first-class condition. The stem was less in diameter and the internodes markedly longer. The accompanying table shows the total length at the end of one month. As only a few branches and rhizomes developed, these are included in the total for each plant.

Growth measurements of Elodea canadensis at the end of 31 days. Original length of each cutting, 10 cm.

Specimen number.	Rooted in soil.	Rooted in sand.	Anchored over soil.	Anchored over sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*
1	117	36	26	35
2	110	28	39	27
3	118	29	18	45
4	220	27	23	40
5	184	34	24	41
6	165	30	32	20
7	171	42	29	38
8	160	45	40	33
9	143	30	31	24
10	Died.	49	22	Died.
Total	1,388	350	284	303
Average	154.2	35	28.4	33.6

The table shows:

(1) An approximate equality of the anchored plants with one another.

(2) A great difference in favor of the plants rooted in soil.

(3) The plants rooted in sand exceed the anchored plants, but hardly enough to establish a positive difference.

CHARA.

Experiment No. 7.—August 20 to September 15. Location and conditions as in preceding. This plant being an alga and much simpler than any of the preceding species in organization, and having rhizoids instead of roots, it seemed probable that it would be found to be independent of a soil substratum for optimum growth. Terminal cuttings 15 cm. long were selected as in preceding cases and the same experiment tried.

Growth measurements of Chara at the end of 26 days. Original length of each cutting 15 cm.

Specimen number.	Rooted in soil.	Rooted in sand.	Anchored over soil.	Anchored over sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*
1	32	39	20	38
2	42	27	24	25
3	56	20	24	21
4	36	20	39	32
5	82	22	23	23
6	40	26	24	16
7	46	52	28	21
8	43	45	22	50
9	35	30	23	28
10	42	33	34	34
Total	454	314	261	288

It will be noticed that the ratios of the respective amounts of growth are the same as for the other plants tried. Those rooted in soil grew most, those rooted in sand next, those anchored over sand about equally with those suspended over soil, and both less than those rooted in sand or in soil.

CERATOPHYLLUM DEMERSUM.

Roots are not present in this plant. The rudiment of a root exists in the embryo, but does not develop when the seed germinates. Growing thus without roots, the plant is easily carried by waves and currents to various habitats, but it occurs most abundantly where least disturbed, usually in protected coves where the water is a meter or two in depth. The finely dissected leaves are borne in whorls, and the segments are rather rigid, so that a plant dragging on the substratum is likely to become anchored. In a sheltered cove where it grows abundantly one may carefully pull up long specimens and usually find that a portion of the stem has been buried and a more or less vertical position secured for the plant. Sometimes the central portion of the axis is buried in the soil so that the two ends of the plant are free. The buried portion is simply bleached; no indications of adventitious organs can be noted.

Experiment No. 8.—Aquarium tests were made with this plant as in the cases preceding. Sufficiently uniform figures for the individuals of a given group were not obtained. Some of the plants in soil grew more than some of those in sand, and conversely. Likewise, the two groups of anchored plants were not comparable with each other, nor with those in sand or soil. In view of such results and the fact that no specialized organs of attachment are produced, it is reasonable to consider that this plant is not directly dependent upon the soil for its growth.

POTAMOGETON OBTUSIFOLIUS.

Experiment No. 9.—It was intended to grow this plant as material for chemical analysis, cuttings being selected from fresh river specimens and placed in floating aquaria as described for *Vallisneria* (experiment No. 1, p. 494). These aquaria were anchored in slowly flowing water in the Huron River, Ann Arbor, on August 14 and remained until September 12. By the latter date the plants were so incrusted as to be disqualified for analysis and only the general result may be recorded.

The difference in favor of the plants rooted in soil was very positive. They had elongated and grown considerably—in fact, behaved as though growing naturally. The suspended plants had failed to grow and showed signs of succumbing to adverse conditions. They had produced numerous unbranched roots, but these decayed after reaching a length of 25 or 30 cm. No rhizomes were produced in either case, the new growth being merely a continuation of branches present when the cutting was made. It may safely be said that this species also is dependent upon the soil for optimum growth.

VALLISNERIA AND CHARA.

Experiment No. 10.—This experiment was conducted at Put-in Bay, Ohio, during the period from August 7 to September 14. Having observed that wherever *Vallisneria* grows best a certain type of soil is likely to be found, it was considered desirable to select the three most distinct types of soil occurring in the vicinity and to tets

them as to the amount of vegetation each can support. To secure natural conditions a platform was built in the lake near the laboratory and on this platform were placed three glass aquaria. The tops of the aquaria were about 15 cm. below the lake level. Each aquarium contained one type of soil as a substratum of about 10 cm. depth. In each aquarium 10 plants of *Vallisneria* and 10 of *Chara* were planted. This material was carefully selected, the individuals being of uniform size, placed in water of favorable depth, and exposed to natural light conditions.

The following table gives the mechanical analysis of the three types of soil as determined by the Bureau of Soils, U. S. Department of Agriculture. The results are expressd in percentages:

Analyses of soils tested for growth of Vallisneria and Chara.

Items.	No. 1.	No. 2.	No. 3.
	Per ct.	*Per ct.*	*Per ct.*
Soluble salts as determined by mechanical analysis	0.42	0.69	0.71
Organic matter	6.50	8.02	4.22
Gravel, 2 to 1 mm	8.78	.84	1.54
Coarse sand, 1 to 0.5 mm	3.40	.62	2.12
Medium sand, 0.5 to 0.25 mm	2.84	.90	1.96
Fine sand, 0.25 to 0.1 mm	12.20	19.40	12.44
Very fine sand, 0.1 to 0.05 mm	3.02	13.30	9.90
Silt, 0.05 to 0.005 mm	47.94	47.56	36.10
Clay, 0.005 to 0.001 mm	14.26	8.05	31.04

The following notes, taken by Prof. F. C. Newcombe, furnish a general characterization of the three soils as determined by observation:

No. 1. Brownish gray throughout, cohesive, very fine texture, little if any grit to the feeling, abundant plant remains in fine fibres, no gas in hydrochloric acid.

No. 2. Blackish gray, gritty, rather coarse, sandy, cohesive, fibrous with plant remains, molluscan shells sparse, yielding much gas in hydrochloric acid.

No. 3. Bluish clay, blotched with buff, hard and coherent, almost no grit, few plant remains, little gas in hydrochloric acid. After the action of acid a granular sediment remains composed apparently of quartz grains.

The experiment shows that soil No. 1 supports the most growth, soil No. 2 next, and soil No. 3 the least growth. The same relation holds for *Chara* as for *Vallisneria*. The relative size of representative plants from each of the three aquaria is shown in figures 3, 4, and 5. The plants were pressed and mounted, the photographs being taken from the herbarium sheet.

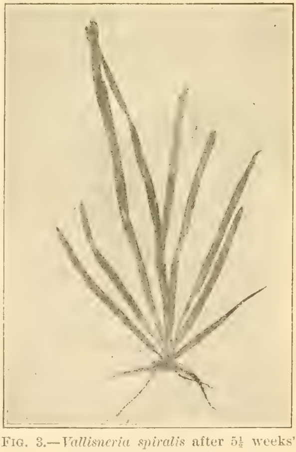

FIG. 3.—*Vallisneria spiralis* after 5½ weeks' growth in loamy soil (No. 1).

Chara being difficult to subject to linear measurement, the air-dry weight of the 10 plants in each case was taken, and this gives a fair index of the relative amount of growth in each soil. In No. 1 it was 2.175 grams; in No. 2, 1.345 grams; in No. 3, 0.650 grams.

The result for *Vallisneria* is just what was expected, but in the case of *Chara* it was thought that since it is of more frequent occurrence in the sandy soil, perhaps it would make a better growth in No. 2 than in No. 1. It is quite possible that this plant is unable to hold possession of the soil of its choice because of the interference from other species. It does occur infrequently along with *Vallisneria* in the loamy soil, making excellent growth there, and since experiment shows this soil to be more favorable than that in which it frequently occurs, we might suppose that it is crowded out from places otherwise suitable for it.

FIG. 4.—*Vallisneria spiralis* after 5½ weeks' growth in sandy soil (No. 2).

Looking to the mechanical analysis as shown above for explanation of these results, it is difficult to find differences indicating those properties which are determining factors in the amount of growth a given soil will sustain. A chemical analysis also is probably necessary.

GROWTH IN NUTRIENT SOLUTIONS.

Having established the fact that certain aquatics do not make an optimum growth either in lake water or ordinary river water unless rooted in the soil, although a substratum of sand and artificial attachment be supplied, it remains to determine whether this fact may be due to insufficient nourishment in the water. Again, from the a priori point of view, if these plants really do absorb nourishment over their entire surface, they ought to thrive in artificial nutrient solutions of suitable strength and composition. Knop's solution was tried, but is too good a medium for the growth of algæ. Sachs's[a] solution is better, and, although osmotically stronger than tap water, is still safe within the limit of suitable strength.

FIG. 5.—*Vallisneria spiralis* after 5½ weeks' growth in clay soil (No. 3).

In the two succeeding experiments two species of plants were grown in each of five conditions, namely:

[a] Sachs's solution is, KNO_3, 1 gram; $CaSO_4$, 0.5 grams; $MgSO_4$, 0.5 grams; $NaCl$, 0.5 grams; $Ca_3(PO_4)_2$, 0.5 grams; dissolved in water to 1 liter.

(1) Soil and tap water, (2) sand and tap water, (3) tap water without substratum, (4) Sachs's solution without substratum, and (5) Sachs's solution with sand substratum.

ELODEA CANADENSIS.

Experiment No. 11.—This experiment was conducted at Ann Arbor during the period from July 10 to August 10. Ten cuttings 10 cm. long, anchored with bits of glass tubing, were suspended in each of five cylindrical battery jars of about 3.25 liters capacity, containing 3 liters of solution with substrata, as already mentioned and as designated in the table. The jars were covered with netting to keep out insects and foreign matter, and, to maintain a sufficiently cool temperature, were sunk in the earth out of doors to within about 6 cm. of the top of the jar. The salts in the Sachs's solution were present in the same proportion as in the formula, and the solution was renewed weekly to prevent the growth of algæ. The tap water was of course likewise renewed.

Measurement of growth of Elodea canadensis at the end of one month. Original length of each cutting, 10 cm.

Specimen number.	Soil and tap water.	Sand and tap water.	Tap water only.	Sachs's solution only.	Sachs's solution and sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*
1	36	19	27	16	30
2	35	28	28	17	25
3	58	16	25	16	29
4	35	22	22	18	31
5	30	33	21	23	30
6	34	27	18	14	29
7	29	24	19	Died.	33
8	40	26	21	Died.	23
9	34	25	Died.	Died.	25
10	54	Died.	Died.	Died.	Died.
Total	385	220	181	104	255
Average	38.5	24.4	22.6	17.3	28.3

It will be noticed from this table that four of the plants in Sachs's solution died before the experiment was concluded, and it is certainly evident that the normal growth of the plants was greatly interfered with. Of the five conditions tested, that of soil and tap water is certainly the best, while that of Sachs's solution without substratum is the least favorable. The remaining three conditions can not be said to show positive differences.

It is a noteworthy fact that not a single root developed on the cuttings anchored in Sachs's solution. Only a few developed in Sachs's solution with sand substratum, while in all the tap-water jars the development of roots was abundant.

POTAMOGETON PERFOLIATUS.

Experiment No. 12.—The location and conditions remain as in the preceding experiment. The duration of the experiment was from August 17 to September 15. Terminal portions, 10 cm. in length, were selected from fresh river plants, and 6 cuttings used in each case. The following table shows the measurements at the end of 27 days:

Measurement of growth of Potamogeton perfoliatus at the end of 27 days. Original length of each cutting, 10 cm.

Specimen number.	Soil and tap water.	Sand and tap water.	Tap water only.	Sachs's solution only.	Sachs's solution and sand.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*
1	115	34	50	20	28
2	83	41	49	24	30
3	130	63	36	24	33
4	105	55	57	32	32
5	82	35	39	25	26
6	80	55	40	24	Died.
Total	595	283	271	149	149
Average	99.16	47.33	45.16	24.83	29.8

The measurements show—

(1) That for this plant, also, soil and tap water furnishes the most favorable of the five environments tested. In this case the plants behaved as under corresponding conditions in the aquarium experiments and as they do in nature. The original cutting grew very little, the increase of growth coming from new rhizomes and secondary shoots from them.

(2) That Sachs's solution furnishes the least favorable of the five environments tested.

(3) That tap water either with or without sand is inferior to soil and tap water, but superior to Sachs's solution.

(4) That in this experiment the differences are decisive, and it is possible that another test would show *Elodea* to behave more nearly like *Potamogeton*.

It was also noted that root development in this species is greatly inhibited, although not completely suppressed, as in the case of *Elodea*, by Sachs's solution.

RANUNCULUS AQUATILIS TRICHOPHYLLUS.

Experiment No. 13.—This experiment was conducted in the greenhouse at Ann Arbor during the period from November 22 to December 26. Three conditions were established. As the plants seem to do better in Sachs's solution when the sodium chloride is absent, this salt was omitted in this experiment. The nutrient solution was identical in each condition, but one jar contained a soil substratum, another sand, and the third was without substratum. The jars stood in the greenhouse and the solutions were renewed weekly. Six cuttings, 10 cm. in length, were selected from the stock aquarium and planted in each jar, those in the jar without

substratum being suspended and anchored with bits of glass tubing attached. The accompanying table shows the increase in length of the plants after a period of 34 days:

Growth measurement of Ranunculus aquatilis trichophyllus at the end of 34 days. Original length of each cutting, 10 cm.

Specimen number.	Anchored without substratum.	Rooted in sand.	Rooted in soil.
	Cm.	*Cm.*	*Cm.*
1	20	20	28
2	19	18	27
3	19	18	28
4	20	18	26
5	18	19	23
Total	115	113	156
Average	19.16	18.83	26

These figures show that a soil substratum favors the growth even in a nutrient medium which contains all the necessary nourishment.

Sachs's solution inhibits the root development here also, but not nearly so much as with *Elodea* and *Potamogeton*. As all three of these plants develop roots abundantly in tap water without a substratum, we may suppose that Sachs's solution contains ingredients which are unsuitable, at least in the given proportion. While it is true that in all my experiments a good plant growth is accompanied by a well-developed root system, it will be remembered that in the aquarium experiments with *Ranunculus* the plants rooted in sand had a good root system, but not a corresponding growth of stem. Although Sachs's solution may be regarded as unfavorable for root development, we can not attribute the retarded growth of the plant to an injurious effect from it unless we assume that the injury is neutralized by the soil, for we get a much better growth in Sachs's solution over a soil substratum.

SIGNIFICANCE AND DISTRIBUTION OF ROOT HAIRS.

Since a root hair is merely a peripheral root cell protruded, the interpretation generally accepted for this structure is that it serves to increase the absorbing surface of the root. If this is correct, and the roots of aquatic plants are only for mechanical attachment, a root hair would seem to be an unnecessary structure in such species.

Many authors have made much of the fact that submerged aquatics show a very rudimentary vascular system and that their anatomy indicates that absorption is not a specialized function of the plant. Perhaps this is somewhat justifiable, but have we not in the presence of root hairs reason for a different opinion? These are such simple structures that they would not be likely to be developed very long after becoming unnecessary; i. e., after the plants bearing them had passed from terrestial to aquatic habits.

Root hairs have been found on the following plants:[a]

Elodea canadensis Michaux. *Philotria canadensis* (Michaux) Britton.
Naias flexilis Rostkovius & Schmidt.
Naias flexilis robusta† Morong.
Potamogeton pectinatus Linnæus. *Potamogeton filiformis* Persoon.
Potamogeton pauciflorus Pursh. *Potamogeton foliosus* Rafinesque.
Potamogeton gramineus Linnæus. *Potamogeton heterophyllus* Schreber.
Potamogeton lucens Linnæus. *Potamogeton lonchites* Tuckerman. *Potamogeton zizii* Roth.
Potamogeton natans Linnæus.
Potamogeton perfoliatus Linnæus.
Potamogeton prælongus Wulfen.
Potamogeton zosteræfolius Schumacher.
Ranunculus aquatilis trichophyllus Gray. *Batrachium trichophyllum* (Chaix) Bossch.
Vallisneria spiralis Linnæus.

The following do not develop root hairs, but are well provided with roots:

Bidens beckii Torrey.
Heteranthera graminea Vahl. *Heteranthera dubia* (Jacquin) MacMillan.
Myriophyllum sparsiflorum Wright. *Myriophyllum spicatum* Linnæus.

BEHAVIOR OF ROOTS AS ORGANS OF ABSORPTION.

ABSORPTION OF LITHIUM NITRATE.

While the experiments already described render the absorption of mineral salts by the roots highly probable, it is of course desirable to secure more direct evidence. For this purpose two methods were employed: First, a 1 per cent solution of lithium nitrate in tap water was offered to the roots, and after a time the upper parts of the plant were tested for lithium with the flame and spectroscope. The second method was merely a direct measurement of the water absorbed.

RANUNCULUS AQUATILIS TRICHOPHYLLUS.

Experiment No. 14.—This was performed in the greenhouse on February 7. A cutting was taken from the stock aquarium and allowed to grow roots which were straight, unbranched, intact, and clothed with hairs. The plant ready for the test may be described as follows: Distance from the node at the base of the cutting to the terminal node, 20 cm.; from the node at the base of the cutting descended one root 20 cm. in length; from the first node above the basal node of the cutting descended one root 10 cm. in length.

As the test must be made with the plant submerged, it is very necessary that none of the lithium nitrate solution escape from the containing bottle into the surrounding water. To separate root and stem an adequate stopper was made by saturating cotton in melted vaseline. Such a stopper can be wrapped around the stem until it snugly fits the bottle. The vaseline makes it water-tight and prevents capillarity along the stem, yet does not injure the plant.

[a] The nomenclature of this list is that of the Index Kewensis, a dagger indicating a more recently established species, and the italicized names the synonyms.

The base of the cutting, including the adjacent portion of the root, being wrapped in the stopper, the plant was located with the longer root inside a narrow-mouth bottle partly filled with lithium nitrate solution. The preparation was then submerged in an aquarium, this arrangement leaving the shorter root outside the bottle and serving as a check on diffusion from the bottle. The distance from the base of the cutting to the level of the solution in the bottle being 4 cm., any lithium escaping from the bottle except through the tissues of the plant would have to do so by capillarity along this root. The preparation was left standing twenty-four hours. The temperature was 17° C. and the weather cloudy.

Upon examination lithium was found in all parts of the stem and leaves, except the terminal node and leaf. No lithium could be detected in the root outside the bottle, not even within 2 millimeters of its union with the stem.

Experiment No. 15.—This experiment was also performed in the greenhouse, the date being March 2. In this case conditions were the same as in the preceding experiment, except that the cutting was allowed to root in a sand substratum and develop numerous lateral roots. This furnished a normal root system, and thus better material for securing an indication of the probable rate of current in the plant. After the plant was well rooted the sand was carefully washed away with as little injury to the roots as possible. The cutting was then left suspended for three weeks to allow any injuries to the roots to heal. The stem of the cutting from base to tip measured 40 cm. Two roots, well branched, descended from the basal node. Both of these roots were placed in the bottle. Other roots arising from higher nodes were left outside the bottle. The distance from the base of the stem to the level of the lithium nitrate solution was 4 cm. The duration of the test was 11.30 a. m. to 4.30 p. m., the temperature 20° C., the sky clear.

Examination revealed the fact that the lithium had traveled upward a distance of 17 cm. from the level of the solution, or 13 cm. in the stem and 4 cm. in the roots. Not a trace of lithium could be found in the roots outside the bottle. One of these roots joined the stem two internodes below the highest point in the stem reached by the lithium. As the lithium had gone upward only 13 cm. out of a possible 40 cm., it is reasonable to assume that these figures approximate the rate of current in the plant.

Mere diffusion will not account for these results, for if the process were simply that, why should not the roots outside the bottles have at least a trace of lithium in the portion close to the stem axis in which the salt was present in abundance? Mere diffusion of salts takes place more rapidly downward than upward.

MEASUREMENT OF ROOT ABSORPTION.

RANUNCULUS AQUATILIS TRICHOPHYLLUS.

Experiment No. 16.—This was performed in the greenhouse in March. By this method the amount of water absorbed by the root is measured directly. The root is inclosed in a bottle (figure 6) provided with an indicating tube in which the water level falls as absorption by the root proceeds. A very simple preparation proved adequate for this purpose. A rubber stopper was pierced with a steel wire and the projecting end of the wire heated until the rubber melted to form a perforation of the desired diameter. The stopper was then divided under water with a sharp razor, a very smooth cut being absolutely necessary. The accompanying figure shows the plan of the apparatus. The indicating tube rises above the level of the water in the aquarium and descends to the level of the stopper's base, so that air bubbles may have an easy exit.

The bottle having been immersed in the aquarium, the root is inclosed by the two halves of the stopper and the preparation set up as figured. Air must be excluded from the bottle and indicating tube. The water level in the tube and that in the aquarium must coincide when the experiment begins. If the preparation is successful a change of temperature in the aquarium water will cause a corresponding change in the level of water in the tube. After this test is made and a uniform temperature established, the experiment may begin. When the experiment is concluded the water level in the aquarium must be the original level and the original temperature must be secured. If under these conditions the level of the water in the tube is below the level of the water in the aquarium, the root must have absorbed a volume of water equal to the volume of the tube contents for the distance between the last level and the level of the water in the aquarium.

The stem axis of the plant used was 20 cm. in length and had 5 nodes with leaves. The cutting bore one straight, unbranched, intact root 14 cm. in length and clothed

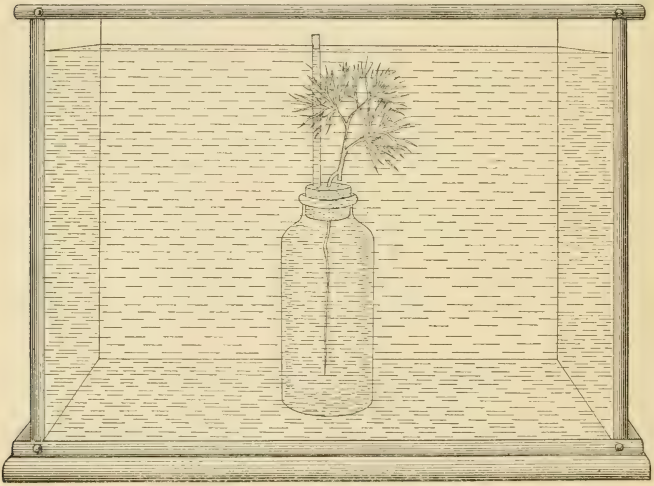

Fig. 6.—Apparatus for measuring root absorption.

with hairs. The water in the tube dropped 15 cm., equal to a volume of 5 c. c., and hence the root absorbed from the bottle this amount of water in twenty-four hours. This test was repeated the following day, the tube receiving the 5 c. c. necessary to make the levels coincide again, and the same result was obtained. It thus appears that a plant of this description at a temperature of 20.5° C. absorbs about 5 c. c. in twenty-four hours.

That the roots do absorb water is therefore considered to be established by two direct methods. One step further would be to measure the water excreted by the stem and leaves. Numerous efforts were made to accomplish this, but no satisfactory apparatus could be devised that would secure reliable results.

CHEMICAL ANALYSIS.

Chemical analysis has been employed for the purpose of securing, if possible, some clew to the reason why certain plants can not make normal growth unless rooted in soil. *Vallisneria* was selected as the material for analysis, and two sets of plants were grown in floating aquaria (the same as described for experiment No. 1), stationed in the lake at Put-in Bay. One aquarium contained anchored plants only; the other contained plants rooted in a soil substratum, and the plants were under these conditions for five weeks during July and August. At the close of this period each set of plants was gathered and thoroughly washed in running lake water. All unhealthy individuals were discarded. The fresh volume of each set was obtained by immersion in water, and came so near being the ratio of 2 to 1 that a few of the suspended plants were left out to secure the ratio. The fresh volume of plants rooted in soil was 1,380 c. c. and of those suspended 690 c. c. This material was then air dried and sent to the U. S. Department of Agriculture for analysis, the results of which are recorded in the following table:

Analysis of Vallisneria spiralis.

	Rooted in soil.	Anchored.
Total weight of material air-dried ....grams..	52.70	37.20
Moisture in material air-dried ....per cent..	9.95	11.45
Total dry weight, moisture deducted ....grams..	47.46	32.94
Ether extract in air-dried material ....per cent..	2.51	1.63
Crude fiber ....do....	16.97	15.73
Ash ....do....	20.34	17.45
Starch ....do....	2.89	6.75
Protein ....do....	16.31	13.44
Pentosans and ligno-cellulose, by difference ....do....	31.03	33.55

Keeping in mind that the fresh volume of the anchored plants was just one-half that of the plants rooted in soil, it will be noticed that this ratio is not sustained in either the air-dry weight or the actual dry weight. It follows, then, that, per unit of fresh volume, the plants anchored contain a larger proportion of dry matter than those rooted in soil. On the other hand, the plants rooted in soil contain a larger proportion of all the constituents determined except starch, the anchored plants having a very marked increase in the proportion of this constituent. The difference in dry weight, then, is attributable to the larger starch content of the suspended plants.

Since the plants rooted in soil have a larger proportion of ash than those anchored, it seems evident that the retarded growth of the anchored plants was due to insufficient mineral food rather than to inhibited photosynthesis. The composition of the ash as determined in terms of dry weight is as follows:

	Plants rooted in soil.	Plants anchored.
Lime (CaO) ....per cent..	1.73	2.13
Magnesium oxide (MgO) ....do....	.73	1.15
Phosphoric acid (P_2O_5) ....do....	.56	.31
Potash (K_2O) ....do....	7.97	6.40

It will be noticed that the anchored plants have a smaller proportion of potash and phosphoric acid. This, together with the diminished proportion of protein, strongly indicates that a sufficient supply of nitrogen, potash, and phosphoric acid was not appropriated by the anchored plants.

It can not be safely concluded from these results that the lake water does not contain nitrogen, potash, and phosphoric acid in sufficient proportion for the plants anchored in it to make a normal growth. It can be said, however, that either these constituents are not present in the lake water in sufficient proportion, or, if they are, the condition of the plants anchored in the lake water is such that these constituents can not be absorbed by the plant in proper proportions. This question will be considered further in connection with other data.

CORRELATION OF GROWTH AND UNCONSUMED STARCH.

Early in this study of growth under varying conditions of nutrition it was discovered that per unit of fresh volume the plants of most growth yielded a smaller dry weight than those retarded in growth by reason of unfavorable conditions. Microscopic examination revealed the fact that the thrifty plants contained comparatively little starch, while those retarded in growth were literally gorged with it. A similar examination at the conclusion of each experiment showed that whether in the aquarium experiments or in those with nutrient solutions, the starch had accumulated in the plants in proportion as growth had been retarded; so it may be said that so far as these experiments are concerned the amount of unconsumed starch in the tissues of the plant varies inversely with the growth. We have thus from direct microscopic examination, as well as from chemical analysis, evidence that the retarded growth in these cases can not be attributed to conditions unfavorable to the photosynthetic process.

LIGHT AND MECHANICAL CONTACT AS FACTORS IN THE DEVELOPMENT OF LATERAL ROOTS.

RANUNCULUS AQUATILIS TRICHOPHYLLUS.

It has been noted that when fragments of this plant are left floating, the new roots arising at the nodes grow directly downward and do not branch until entering a substratum.

Three conditions suggest themselves as possible factors in determining the development of these lateral roots. The first is light; the second, mechanical contact as a stimulus; the third, a difference of osmotic strength between the solution in the soil and that above it. The last supposition is very improbable, as lateral roots develop abundantly in clean washed sand, and in this case the roots are probably exposed to a solution whose osmotic strength is the same as that of the solution above the sand. The following test was made with a view of ascertaining the determining factor:

Experiment No. 17.—This experiment was conducted in the greenhouse from April 10 to May 18. Fresh cuttings, 25 cm. in length, were mounted in 10-ounce bottles, submerged in tap water contained in cylindrical battery jars. A loose cotton stopper wrapped about the cutting kept it in proper position, and did not prevent the diffusion of water inside the bottle with that outside. Four conditions entered into the test: Bottles wrapped in black cloth to exclude light; bottles not covered, roots being exposed to light; bottles not covered, but containing sand, and bottles not covered, but containing granulated glass.

About three nodes of the cutting were inside the bottle in each case, and when first mounted the cuttings were without roots. Five cuttings were in conditions 1 and 2, and 3 cuttings in conditions 4 and 5. In No. 4 the intention was to have mechanical contact with a transparent substratum, but a layer of glass deep enough for a substratum greatly reduces the light. In no case did roots from nodes above the stopper have lateral branches, and, as the number of these roots was practically equal to the number arising from nodes below the stopper, only the latter are given in the table.

Influence of light on the development of root system of Ranunculus aquatilis trichophyllus.

Condition.	No. of main roots.	Total length of main roots.	Average length of main roots.	No. of lateral roots.	No. of lateral roots per main root.	Total stem length.
		Cm.	*Cm.*			*Cm.*
Wrapped bottles	22	1,048	47.63	73	3.3	191
Unwrapped bottles	28	459	16.4	0	0	170
Sand substratum	15	262	17.46	66	4.4	....
Glass substratum	16	296	18.5	13	.81	....

These figures show (1) that, other conditions being equal, light inhibits the formation of lateral roots and retards the growth of main roots; (2) that plants with roots in wrapped bottles and consequently a more extensive root system do not make a proportionately greater growth in stem length. The remaining figures are of little value as they stand.

RECAPITULATION AND THEORETICAL DISCUSSION.

Seven species of frequent occurrence in our aquatic flora have been submitted to a direct test to determine the influence of a soil substratum upon their growth. In five of these cases the actual growth in length has been measured. All of the seven species grow naturally rooted in the substratum. *Chara* has only rhizoids, of course, but the others have roots, and, with the exception of *Myriophyllum*, root-hairs also. Not one of these plants can make an optimum growth in tap water if the roots are prevented from entering the substratum. If allowed to root in clean-washed sand a better growth is obtained, but not nearly so good as when the roots freely penetrate a good soil. The difference in amount of growth between plants rooted in sand and those in soil, in terms of the former, was for *Potamogeton*, 480.36 per cent; for *Elodea*, 340.57 per cent; for *Ranunculus*, 62.96 per cent; for *Myriophyllum*, 46.43 per cent; for *Chara*, 44.58. No reason is apparent for not considering these figures as indicating the relative dependence of the different species upon the soil. This is, however, a secondary matter as compared with the fact, herein demonstrated, that a soil substratum is requisite for normal growth. The root-development of the anchored plants is undoubtedly retarded by exposure to light, but, as is shown in experiment No. 17 (p. 515), with *Ranunculus*, the more extensive root-system is not accompanied by a correspondingly greater growth in stem length. Why the plants rooted in sand should do so much better than those anchored above sand is not altogether certain, but the more extensive root-system which develops in sand will account for a part of the difference. That a sand substratum 10 or 15 cm. deep should concentrate the salts of the supernatant water to a degree sufficient to influence the amount of growth is hardly probable. In each case the sand was thoroughly clean when the experiment began, but some undissolved substance may have become embedded in it during the experiment, although the water in the aquarium was frequently stirred and siphoned out.

In experiment No. 10 (p. 504) sandy, clayey, and loamy soils were compared with respect to the suitability of each, and it appears that *Vallisneria* and *Chara* make a better growth on a good loam soil, just as many land plants do.

The experiments with Sachs's solution show that the plants can not make as good a growth in it, either with or without a substratum, as in soil and tap water. These experiments are not as extensive as they should be and must be regarded as indicating rather than establishing conclusions. What is the most suitable solution for those plants and whether they will make an optimum growth in any solution unless rooted in a substratum must be left as open questions. The suitability of Sachs's solution for many land plants is well known, and why these aquatics should be unable to grow in it can, so far as these experi-

ments have gone, be only surmised. It is noteworthy that in the absence of a substratum Sachs's solution totally inhibits root formation in the case of *Elodea;* with *Potamogeton* a very few roots appear, but shortly die; with *Ranunculus* more roots appear, but they reach a length of only a few centimeters. All of these plants will develop roots better in Sachs's solution if allowed to send them into a sand substratum, but even here the development is much less than with plants anchored in tap water without a substratum. It is evident that the sand substratum, as well as the solution and light, is a factor influencing root development, unless we assume that the sand changes the strength or quality of that part of the solution which saturates it. True and Oglevee (1904) found that the presence of insoluble substances, such as sand, paraffin, and filter paper, in solutions "exerts an effect closely paralleling that of simple dilution." As the Sachs's solution was frequently renewed we can not suppose that the quality of the solution gradually became unfavorable during the experiment. In experiment No. 13 (p. 508), where *Ranunculus* is grown in Sachs's solution without a substratum, with a sand substratum, and with a soil substratum, we see that the soil here is a very important factor. The average length in the three groups was 19.16 cm., 18.8 cm., and 26 cm., respectively. This brings out the interesting fact that the soil in some way helps the plant under otherwise unfavorable conditions.

That the roots of most of our common aquatics are provided with root hairs is significant, and certainly indicates that absorption is an important function of the roots. It is interesting to note in this connection that of the two species found to be least dependent upon the soil, one is *Chara*, an alga with only rhizoids instead of roots, and the other *Myriophyllum*, which has roots, but not root hairs.

Experiments 14 and 15 (pp. 510 and 511) demonstrate that the roots will absorb lithium nitrate and that the salt is carried upward into the stem and leaves. Reference to the experiment will show that diffusion will not account for this result and there is no escape from the conclusion that an upward current carries the salt to the leaves.

Experiment 16 (p. 511) demonstrates the absorption of a given amount of tap water in a given time by the roots developed from cuttings suspended in tap water. It was not intended here to determine the rate of absorption, but only to demonstrate the fact. It is to be regretted that the several attempts made to measure the exudation from the stem and leaves were unsuccessful. Hochreutiner's efforts to do the same thing were not rewarded by results because of the difficulties encountered in the technique. If, however, a large absorption is a fact, the exudation is a necessary consequence. Whether this exudation is in any way comparable to the transpiration of terrestrial plants is an interesting and relevant question, but the answer to such an inquiry is not considered possible on the basis of these experiments.

The chemical analysis of *Vallisneria* shows that the metabolism of plants denied a substratum is very different from that of plants allowed to root in the soil. The former show a marked excess of calcium and magnesium, while the latter contain a larger proportion of protein, potassium, and phosphorus. This change of metabolism manifests itself outwardly by a greatly retarded growth, and microscopic examination reveals that an abnormal amount of starch has accumulated in the tissues. This accumulation of starch is so great that the dry weight of a given fresh volume is considerably more than is obtained from an equal fresh volume of plants grown rooted in the soil.

The last experiment, No. 17, with *Ranunculus*, shows that light is the factor which prevents the formation of lateral roots and which also retards the growth of the main root. However, the more elaborate root system which develops in the dark does not aid the plant to make a proportionately greater growth when the roots are not allowed to enter the soil.

From the aquarium experiments it is evident that these attached aquatics are dependent upon the soil for optimum growth. Not one of the species investigated, except possibly *Chara*,[a] can survive the growing season unless rooted in the soil, and even *Chara* does not make an optimum growth under any other conditions.

While the aquarium experiments establish the fact as stated, they do not furnish adequate explanation of the fact. It may first be asked: Does the soil furnish plants rooted in it with substances that are not available for plants suspended in the water over it?

Concerning this question we may consider, first, that soils have the property of withdrawing salts from solution. Way (1850) discovered that liquid manure filters through soil to a clear solution containing both organic and inorganic matter in diminished quantity. Liebig (1858, p. 109) and others took up the matter until this absorptive capacity of soils is well established. For a time authors were divided as to whether this fixation, or rather retention, of salts by the soil is a physical or chemical process, but the general agreement now is that both physical and chemical processes operate. (Kubel-Tiemann-Gärtner, 1889.) Pfeffer (1900, p. 166), summarizing from the various researches, states that most soils absorb the oxides, salts of the alkalies, and alkaline earths of potassium, ammonium, magnesium, sodium, and calcium in relative quantities in the order mentioned. It must be remembered, however, that this retention of dissolved substances by the soil is neither absolute nor permanent.

In the case of the lake there are probably operating two opposing

[a] Davis (1901) states that culture experiments made by him demonstrated the fact that *Chara* takes its lime from the water and not from the soil. However this may be, it is certainly true that *Chara* makes its best and most vigorous growth when rooted in a good soil.

processes, in which the soil tends to withdraw salts from solution, and the water tends to bring salts of the soil into solution. Excluding other factors, these two processes would probably establish an equilibrium resulting in a constant concentration. But plants, and especially those attached to the soil, are important factors in the redistribution of matter, which is constantly going on. The roots in respiration excrete carbon dioxide, which helps to bring otherwise insoluble salts into solution.

Apparently the substances needed by the plants are the ones most firmly retained by the soil, and yet it can not be said that the water does not contain enough of these salts for the larger plants. That plants have a quantitative selective power is certain, and their capacity for concentrating salts from very dilute solutions is well established, especially in the case of potassium in land plants and of iodine in some marine forms. Liebig (1858, p. 140) found that the ash of *Lemna* contained of potassium 13.16 per cent and of phosphoric acid 8.73 per cent, while the inorganic residue from the water in which the *Lemna* was growing contained these substances in the respective proportions of 3.97 per cent and 2.619 per cent. As *Lemna* and *Ceratophyllum* must derive their mineral nourishment exclusively from the water, it is evident that the necessary salts are present, and in sufficient quantity for some plants.

Granted, then, that the necessary salts are present, though in very small quantity in some cases, it may next be asked: Are the salts present in suitable proportion? The evidence at hand hardly furnishes satisfactory reply. Chemical analysis of *Vallisneria* indicates that they are not. The marked excess of calcium and magnesium in the anchored plants is a noteworthy fact. According to Loew's (1901, p. 16) hypothesis, calcium is especially required for the formation of nucleoproteids and magnesium for facilitating the assimilation of phosphoric acid. Should the excess of lime be too great, the magnesium is displaced and the phosphoric acid, combining with the lime, becomes insoluble. The result (Loew, 1901) is the same as if the supply of phosphoric acid were too limited, and the plant succumbs to starvation. Loew's hypothesis is hardly applicable to my results, however, as the ratio of magnesium to calcium in plants rooted in soil is about the same as that in the anchored plants.

The accumulation of starch in the anchored plants is the most positive evidence of abnormal metabolism revealed by the chemical analysis, and this, in connection with the retarded growth, furnishes a basis for further investigation. Is the growth retarded because the starch is formed too rapidly, or does the starch accumulate because growth is retarded? Pfeffer (1900, p. 515) states that "the mobilization of reserve food materials is regulated by the amount consumed;" also (p. 425), "when growth is inhibited the consumption, and hence also

the translocation, of carbohydrates ceases, so that if the assimilation of carbon dioxid is possible, the assimilatory products will accumulate in the leaves until the inhibitory limit is reached, and this result will be produced whether the stoppage of growth is due to a deficiency of potassium or phosphorus, or to widely different causes." From this point of view the accumulation of starch is a consequence and not a primary cause of retarded growth.

Proteid synthesis is the other very important metabolic process, and the chemical analysis does suggest some interference with this function. The diminished quantity of potassium and phosphorus may mean that the plants could not assimilate these elements rapidly enough to furnish proteids for new tissue. (Pfeffer, 1900, p. 430.) With proteid synthesis once retarded pathological conditions would soon arise; non-diosmosing substances might be formed which would still further interfere with normal metabolism; the activity of enzymes might be inhibited, thus favoring starch accumulation—in fact, we might make several suppositions, all of which would be more or less directly associated with inhibited proteid synthesis. On the other hand, starch formation itself requires proteids for the plastids; but it is not known what may be the capacity for photosynthesis of the plastids already present before abnormal conditions arise.

Further, it may be asked: Is a uniform environment unfavorable to the plant? When the roots are in contact with the substratum a possibly much better opportunity is afforded for exercising a quantitative selective power than when they are merely hanging in a solution identical with that which surrounds the remainder of the plant. Perhaps this diversity of environment means much to the plant by way of favoring the excretion of waste products as well as securing larger quantities of certain salts.

This leads to the final inquiry: Is the function of absorption localized? The plants which naturally live independently of a substratum have a much simpler structure than those like *Ranunculus* or *Potamogeton*, and it is quite possible that in the latter cases the functions of absorption and excretion are so localized that the plant can not continue normal metabolism when bathed over its entire surface with one nutrient solution, even though the solution contain all the necessary ingredients in suitable proportion and chemical combination. Possibly one benefit of a substratum is to furnish the roots with a solution which is not isotonic with that which bathes the leaves, although isotonic must be considered here as applying to each salt individually, as the plants have a varying capacity for absorbing and incorporating different salts.

The presence of root hairs may be regarded almost as prima facie evidence that the roots bearing them are organs of absorption. That root hairs are absent in some few species is not evidence that they are

unnecessary structures for water plants in general, for there are terrestrial plants (Schwarz, 1881–1885, p. 168) whose roots do not develop root hairs.

The necessity for going further into the chemistry of plant metabolism is apparent, and we can only say that when these plants are denied a substratum of soil the normal processes of metabolism are altered to a fatal degree.

CONCLUSIONS.

1. *Vallisneria spiralis*, *Ranunculus aquatilis trichophyllus*, *Elodea canadensis*, *Myriophyllum spicatum*, *Potamogeton obtusifolius*, and *P. perfoliatus* are dependent upon their rooting in the soil for optimum growth, and can not survive a single season if denied a substratum of soil.

2. The roots of these plants are organs of absorption as well as of attachment.

3. There is an upward current in these plants, from roots to stem and leaves.

4. When these plants are denied a substratum, pathological conditions arise which are manifested by an accumulation of starch and a retarded growth with subsequent death.

5. The retarded growth of plants denied a substratum is not due to inhibited photosynthesis.

6. The plants anchored over a soil substratum do not have a more favorable environment than those anchored over a clean washed sand substratum.

7. Many of the plants rooting in soil develop root hairs, and the presence of these structures is the rule rather than the exception.

8. In the case of *Ranunculus aquatilis trichophyllus* light inhibits the formation of lateral roots.

9. *Ceratophyllum* and some other floating plants are able to absorb their nutrient salts directly from the surrounding water.

From the results of this investigation the following deductions are considered probable:

1. The above conclusions are applicable to all aquatic plants which grow rooted in a soil substratum, and especially to those whose roots are provided with root hairs.

2. The primary cause of the retarded growth of anchored plants is their inability to secure enough phosphorus and potassium, and possibly other elements.

3. When proteid synthesis is inhibited by an insufficiency of phosphorus and potassium, pathological conditions arise which permit the accumulation of starch.

4. These plants are terrestrial forms adapted to an aquatic habit rather than descendants of plants in which the functions of absorption and excretion are not localized.

5. These rooted aquatics are important contributors to the plankton food supply, because when living they organize matter that may be used as food and in death they yield important salts and organic substances to the water. Artari (1901) finds that certain algæ prefer organic nourishment, and it is quite possible that many of the forms so abundant on wounded and decaying portions of the larger plants derive considerable nourishment therefrom.

ECONOMIC SIGNIFICANCE OF RESULTS.

The foregoing investigation may be regarded as a step in the endeavor to ascertain those factors which determine the quantity of food fish occurring in the Great Lakes. From the introduction it appears that the larger plants are already credited with favoring the increase of fish food by protecting the bottom soil against wave action, and by affording a shelter for many small animals and young fish, as well as by acting as mechanical supports for the algæ, which are used as food by many animals. If the observations recorded in this paper are correct, there must now be definitely assigned to the rooted aquatic plants a nutritive rôle of which they have hitherto been only suspected. The roots of the plants investigated are true absorbing organs, taking from the soil valuable salts that would otherwise be retained by it, and furnishing these salts to the growing stems and leaves for the building up of more plant tissue. So dependent upon the soil are these rooted aquatics that they can not survive a growing season if deprived of it. Thus, instead of taking their mineral food exclusively from the water, as formerly supposed, and so temporarily withdrawing valuable salts from the water, these rooted aquatics take their food from the soil and organize it into vegetable matter. Upon the decay of the vegetable matter this food material is believed to pass into solution in the water. It should there nourish the plankton algæ, which, in their turn, are used as food by the smaller animal forms, and these in turn are fed upon by larger animals and by fishes.

In western Lake Erie, where large areas of the substratum in coves and bays are occupied by dense fields of plants (aquatic meadows), the changing winds often create currents which carry out into the lake large quantities of plant débris. This during the period of slow oxidation represents so much organized matter available for plankton nutrition, and in final decay yields important mineral salts to the water, thus adding to the food supply of the plant plankton.

That there is a direct relation between the quantity of food fish and the quantity of plankton has long been believed. Recently Kofoid (1903) has produced quantitative evidence to show that in the Illinois River and its back waters such a relation exists, in the sense that "there is in general a correspondence between plankton production and the product of the fisheries, in that the direction of movement in

both is usually the same. They rise or fall together." The argument presented by Kofoid will not be critically discussed here.

In view of the results obtained in this investigation, it appears highly probable that through the mediation of the attached plants the abundant mineral salts held fixed by the soil become available for the nourishment of the phytoplankton. On this basis it is possible to attribute the scarcity of plankton and fish in some waters in part at least to the scarcity of the larger, rooted, aquatic plants. Kofoid (1903) shows, in the case of Flag Lake, that an abundant rooted vegetation is favorable to a high plankton production. In the other lakes examined by him he has made careful measurements of the plankton at frequent intervals for a period of five years, and he divides these lakes into two groups—vegetation rich, which contain an abundance of submerged aquatic plants, and vegetation poor, which contain but little submerged aquatic vegetation. He concludes from his measurements of the plankton that the vegetation-rich lakes produce less plankton than the vegetation-poor lakes. He says: "This relation of vegetation to plankton may be formulated as follows: The amount of plankton produced by bodies of fresh water is, other things being equal, in some inverse ratio proportional to the amount of its gross aquatic vegetation of the submerged sort." (Kofoid 1903, p. 484, footnote.) The relatively small amount of plankton in vegetation-rich lakes Kofoid attributes to a number of factors. In part it is due to the fact that the vegetation shuts out the heat and light of the sun and thus keeps all but the surface layer of water in shade and at low temperature, so that plankton algæ do not develop readily. In part it is probably to be attributed to the presence of plankton-eating animals which find shelter in the dense, gross vegetation. Chiefly, however, he attributes it to the fact that the larger aquatic plants take from the water and utilize in their growth the greater part of the available food materials. Thus plankton vegetation is unable to develop because the water has been depleted of the food substances necessary for its nutrition. Hence the development of an abundance of submerged aquatic vegetation results in a diminished plankton, while a scant submerged vegetation is correlated, other conditions being the same, with a more abundant plankton.

While Kofoid recognizes in the case of Flag Lake that an abundant rooted vegetation is favorable to plankton production, he points out that this vegetation is either succulent (*Sagittaria*, *Pontederia*, *Nymphæa*, *Nelumbo*), in which case it dies down and decays in early fall, or it is emergent (e. g., *Scirpus*), in which case it dies down and decays when broken down by ice and winter floods. The vegetation of Flag Lake is rooted, and Kofoid suggests that the richness of the lake in plankton is to be attributed to the food materials drawn from the soil by these rooted aquatic plants and dissolved in the water by

their decay. So far as concerns vegetation like this, his conclusions are precisely those which seem necessarily to follow from the experimental results recorded in this paper.

In contrast to Flag Lake, however, are Dog-fish and Quiver lakes, which are filled with a rich growth of submerged vegetation. This "consists in the main of *Ceratophyllum*, with an admixture of *Elodea* and *Potamogeton* toward the margin" (Kofoid, 1903, p. 244). It is this sort of submerged non-rooted vegetation which Kofoid shows to be unfavorable to an abundant plankton, so that lakes which contain it and which he calls vegetation-rich have less plankton than otherwise similar lakes which are without it. The conclusion that an abundance of submerged vegetation is inimical to the development of a rich plankton seems at first sight to be at variance with the conclusions reached in this paper, and Kofoid's general formula, "The amount of plankton produced by bodies of fresh water is, other things being equal, in some inverse ratio proportional to the amount of its gross aquatic vegetation of the submerged sort," is certainly not in accordance with these conclusions. Yet the apparent contradiction between his results and those here recorded disappears when it is remembered that the submerged vegetation to which he has reference is composed chiefly of *Ceratophyllum*, and that *Ceratophyllum* is a rootless form, which undoubtedly draws its food supply from the water only. It thus competes with the phytoplankton for food, and an abundant growth of it is necessarily correlated with a scant growth of phytoplankton. On the other hand, the submerged vegetation considered in this paper is rooted; it draws its mineral nourishment from the soil and in decay yields it to the water. It does not, therefore, compete with the phytoplankton, and its presence is, from a nutritive standpoint, favorable to the development of phytoplankton.

From the standpoint of nutritive relations, then, all vegetation of fresh waters may be divided into two classes: (1) The rooted vegetation, which may be either emergent (e. g., *Scirpus*) or submerged (e. g., *Vallisneria*, etc.), and which includes nearly all the gross aquatic plants. Of these it may be said that they draw their mineral food from the soil and are thus favorable to the growth of the phytoplankton. (2) Nonrooted vegetation, consisting of (a) gross, nonrooted phanerogams, made up almost wholly in temperate regions of *Ceratophyllum* and the *Lemnaceæ*, and (b) minute, nonrooted cryptogams, which are mostly members of the phytoplankton. All these nonrooted plants draw their mineral food from the water, and hence the two subdivisions, the gross and the microscopic, compete with one another, so that an abundance of nonrooted gross plants results in a reduced plankton. Kofoid's formula modified to bring it into accord with all the facts would read, "The amount of plankton produced by bodies of fresh water is, other things being equal, in some inverse ratio proportional to the amount of its gross nonrooted vegetation and in some

direct ratio proportional to the amount of its gross rooted vegetation." In the final paragraph of that part of his paper which deals with this subject, Kofoid (1903, p. 502) recognizes that the distinction should be drawn between rooted and nonrooted vegetation, and suggests that experimental proof is desirable for the generalization which he advances. Such experimental proof I had already offered (Pond, 1901) in a preliminary note, to which Kofoid does not refer, though he refers to Pieters (1901, p. 73, footnote), in which this note is cited. (See also Pond, 1902, p. 89.)

If we accept the conclusions reached in this paper that gross rooted vegetation is favorable to plankton production, and if we further accept the current argument that fish production is dependent on plankton production, the practical application of the results of this investigation are simple. In the stocking of ponds for fish culture care should be taken to have a good soil for the bottom; not a stiff clay nor sand, but a good loamy soil, such as is favorable for land plants. The species allowed to grow should be those which are known to possess roots and to be very dependent upon the soil, such as *Vallisneria spiralis*, the so-called eelgrass, and *Potamogeton*, or pond weeds; not forms without roots, such as *Ceratophyllum*, or those less dependent upon the soil. In natural lakes choked with a growth of *Ceratophyllum*, the removal of this form and the substitution for it of rooted plants offer possible means of increasing the supply of edible fish.

The poverty of the Great Lakes in plankton may be attributed to several causes. One of these is, doubtless, the relatively small shore area in these waters occupied by rooted aquatics. The comparatively short shore line, the narrowness of the shore area, and the mechanical action of the waves, all tend to limit the growth of rooted plants, hence to limit the productive capacity of the lake in plankton and, according to the current belief, in fishes.

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PUBLICATIONS OF THE UNITED STATES COMMISSION OF FISH AND FISHERIES AVAILABLE FOR DISTRIBUTION ON JUNE 30, 1903.

PUBLICATIONS OF THE COMMISSION OF FISH AND FISHERIES AVAILABLE FOR DISTRIBUTION JUNE 30, 1903.

The publications of the Commission consist of an annual report and an annual bulletin, which are Congressional documents. A certain number of copies are allotted to Senators and Representatives, and a small part of the edition is assigned to the Commission. Each volume is made up of separate papers treating of the different subjects germane to the work of the Commission, and a limited edition of these papers is issued in pamphlet form in advance of the bound volume for distribution to those especially interested in the subject-matter. The publications of which copies can be supplied to persons particularly interested are shown in the following lists. The issuance of several reports already in type has been anticipated, so that the list covers probably all papers which will have been printed to July 1, 1904.

Of the bound publications, all the earlier volumes are out of print, and all the copies allowed the Commission have been distributed. A few copies of the reports and bulletins for the years indicated can be furnished. Each pamphlet has a serial number, by which it may be designated in making application therefor; the numbers missing from the list are out of print and can not be supplied. Bound reports and pamphlets that are no longer available at this Commission may sometimes be obtained by addressing the Superintendent of Documents, Washington, D. C., or may be consulted at most of the prominent libraries and educational institutions in this country and abroad.

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XXVII	1901	1902	VI+844	37
XXVIII	1902	1904	III+549	38
Annual Bulletin				
Vol. XIX	1899	1901	VI+501	44+XXXIV
Vol. XX, first part	1900	1902	XV+524	52, 17+IV+XXXVIII
Vol. XX, second part	1900	1902	VIII+416	A+XII
Vol. XXI	1901	1902	VII+476	22, XLIV+A

PAMPHLET PUBLICATIONS.

Serial No.

3. Report on the condition of the sea fisheries of the south coast of New England in 1871 and 1872, by Spencer F. Baird. Report for 1871–72, pp. I–XLI. 1873.
21. Cheap fixtures for hatching of salmon, by Charles G. Atkins. Report for 1878, pp. 945–966 (including 15 figs.). 1880.
40. Popular extracts from the investigation of the commission for the scientific examination of the German seas, by H. A. Meyer and others. Report for 1879, pp. 525–557 (including 17 figs.). 1882.
41. List of dredging stations of the U. S. Fish Commission from 1871 to 1879, inclusive, with temperature and other observations, by Sanderson Smith and Richard Rathbun. Report for 1879, pp. 559–601. 1882.
62. Report of the Commissioner for the year 1880, by Spencer F. Baird. Report for 1880, pp. XVII–XLVI. 1883.
65. Report of the Commissioner for 1881, by Spencer F. Baird. Report for 1881, pp. XIII–LXXI. 1884.
70. Report on the construction and work in 1880 of the Fish Commission steamer *Fish Hawk*, by Z. L. Tanner. Report for 1881, pp. 3–53, plates I–XVIII (including 3 figs.). 1884.
73. Annual report on the electric lighting of the U. S. F. C. steamer *Albatross*, December 31, 1883, by G. W. Baird. Bulletin for 1884, pp. 153–158 (including 8 figs.). 1884.
131. Report of operations at the Wytheville Station, Va., from January 1, 1885, to June 30, 1887, by Marshall McDonald. Report for 1886, pp. 793–800, plates I–VI. 1889.
137. Suggestions for the employment of improved types of vessels in the market fisheries, with notes on British fishing steamers, by J. W. Collins. Bulletin for 1888, pp. 175–192, plates XVI–XXVII. 1890.
138. Notes on the fishes collected at Cozumel, Yucatan, by the U. S. Fish Commission, with descriptions of new species, by Tarleton H. Bean. Bulletin for 1888, pp. 193–206, plates XXVIII–XXIX. 1890.
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